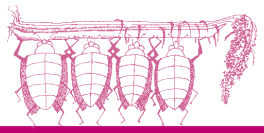

Galerucella

Lythrum salicaria

SEE CELLA CHOW!

A Purple Loosestrife Biological Control Manual for Educators

2003

WISCONSIN DEPARTMENT OF NATURAL RESOURCES • WISCONSIN WETLANDS ASSOCIATION

SEE CELLA CHOW!

A Purple Loosestrife Biological Control Manual for Educators

2003

WISCONSIN DEPT. OF NATURAL RESOURCES

Wisconsin Wetlands Association

Activities contained in this curriculum unit were compiled and adapted by Greg Bisbee, Dave Blumer, Dave Burbach, Bret Iverson, Donna Kemp, Laura Richter, Shirley Sklavos, Derek Strohl, Barb Thompson, Robert J. Welch, Catherine Werts, and Brock Woods. This packet reflects the work done by the above educators in an August 2001 workshop coordinated by the Wisconsin Wetlands Association (WWA) and the Wisconsin Department of Natural Resources (DNR). Their diligent work and substantial contributions are appreciated.

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"Cella" drawings courtesy of Rita Hayen.

The *Galerucella* life cycle drawing on page 31 originally appeared as Fig. 2 in Richard A. Malecki, *et al.* 1993. Biological Control of Purple Loosestrife. *BioScience* (November, vol. 43, no. 10). Copyright, American Institute of Biological Sciences. Used with permission.

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The map appearing on page 81 is taken from the Department of Natural Resources' brochure entitled Purple Loosestrife. 1990.

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CONTENTS

To all Wisconsin Educators—

Wisconsin is blessed with lots of beautiful wet places and many people who perceive a deep connection to those places. We hope that this publication will deepen that connection for both you and your students.

Purple loosestrife, as you will find out in greater detail in the pages to follow, has been in Wisconsin since the early 1900s. Only recently, however, has it been recognized as a major problem, taking on labels like "nuisance," "pest," "invader," and even "a deadly threat to Wisconsin's wetlands."

Citizens can now get involved in loosestrife control efforts. The Wisconsin Department of Natural Resources (DNR) has developed a program to engage citizens in this work, especially through rearing and releasing biological control insects. Teachers have found this project to be a practical undertaking at schools and the basis for more effective teaching about plants, insects, invasive species, wetland ecology, and myriad other topics. In fact, the project supplies the final, crucial step in turning students into true environmental citizens, that of personal involvement and success in solving real-life environmental problems.

But once you're rearing beetles, how can you infuse the experience into your lesson plans? In summer 2001, the Wisconsin DNR and the Wisconsin Wetlands Association (WWA) convened 10 educators at the Central Wisconsin Environmental Station to develop a series of classroom teaching activities centered on the biological control (bio-control) process. Teachers started by reviewing existing activities, modifying them as needed, then created complementary ones. Over the course of the 3-day workshop we selected 15 of the best activities about state wetlands for use in Wisconsin classrooms. These are the activities you have here. Topics range from a host plant-specificity experiment to an invasive plant art project. Applicable model Wisconsin science and environmental education standards are listed for each activity.

How and when to use these activities is up to you. Though we have put them in a sequence logical to us, it is our intention that you use them in any order that fits your curriculum.

This publication is only part of a growing solution to invasive species, one that taps nature to control the problem and involves reconnecting people to the land. The solution grows as WWA recruits and trains volunteers to survey purple loosestrife in Wisconsin, as the Wisconsin DNR explores potential biological control agents for other invasive plants, and as you awaken one more student to the interdependence of all living things. More information about this solution can be found at **www.wiscwetlands.org** and **www.dnr.state.wi.us**.

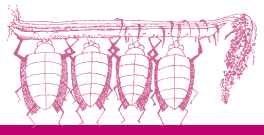
Thank you for your participation and keep up the good work.

Most sincerely,

Wisconsin Wetlands Association

Brock Woods

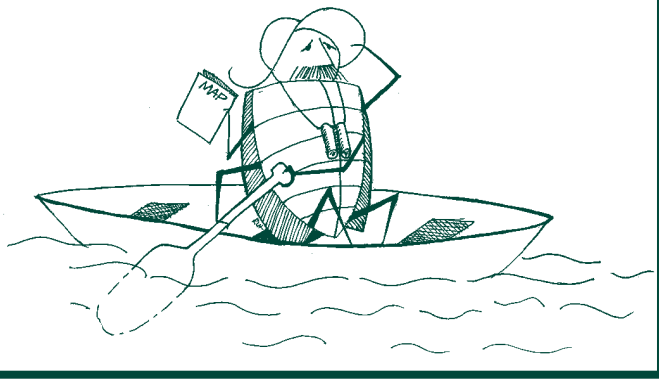
Wisconsin DNR and UW-Extension
Purple Loosestrife Biological Control Project

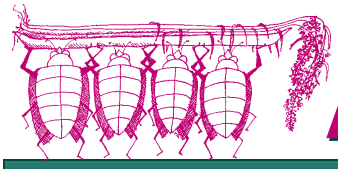


Galerucella

Lythrum salicaria

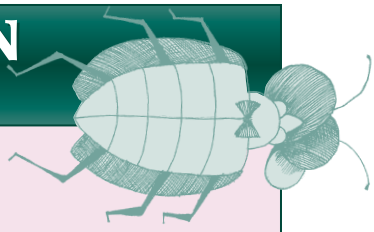
THE ACTIVITIES


MAP



ACTIVITY 1 GRADES 8-12

ALIENS MOVING IN NEXT DOOR*



Objectives

➡ **Students will become familiar with the impact of exotic species (specifically purple loosestrife) on ecosystems by investigating a local schoolyard plant's biotic potential and environmental resistance.**

➡ **Students will create an imaginary exotic plant to compete for a local plant's niche and evaluate the possible results.**

➡ **Students will be able to define the terms biotic, abiotic, biotic potential, environmental resistance, native species, exotic species, and invasive species.**

Time Requirement

Three 45-minute class periods.

Wisconsin Model Environmental Education and Science Standards

***Environmental Education*: A.8.1, A.8.4, A.8.5, B.8.8, D.8.5, D.8.6, A.12.1, B.12.3, B.12.6, C.12.1. *Science*: A.8.6, B.8.4, C.8.1, C.8.2, C.8.5, C.8.10, C.8.11, F.8.1, F.8.2, F.8.6, F.8.7, F.8.8, F.8.9, G.8.5, H.8.2, A.12.4, A.12.3, C.12.1, C.12.5, F.12.5, F.12.7, F.12.8, G.12.2, G.12.5, H.12.4.**

DESCRIPTION

Students discover and apply information about a schoolyard plant's biotic potential and environmental resistance. Students chart the information and predict results of the introduction of an imaginary invasive species and apply this learning to the problem of purple loosestrife.

PROBLEM

What are the characteristics of a plant that allow it to become dominant within its environment?

MATERIALS

- ❑ Plant identification books.
- ❑ Clipboards.
- ❑ Plain paper.
- ❑ Background information on purple loosestrife (page 7).

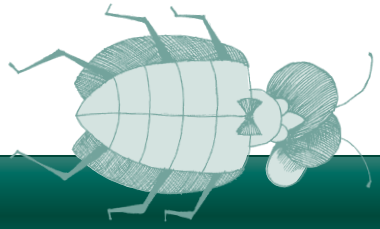
PROCEDURES

1. In the classroom, introduce the concept of dynamic balance between biotic potential and environmental resistance relative to population growth. Take a mini-field trip outside in the schoolyard. Ask students, in small groups, to identify plants growing in the schoolyard and choose one for further investigation.

2. Have students create a chart to list the biotic potential and environmental resistance for each chosen schoolyard plant using plant books, encyclopedias, the Internet, and field observation.

Quackgrass

BIOTIC POTENTIAL	ENVIRONMENTAL RESISTANCE
Reproduction: runners and seeds	Competitors: dandelions, crabgrass, etc.
Growth: rapid	Drought
Migration: man spreads it, runners grow rapidly, seed dispersal	Predators: herbivores; mowed by people
Coping: hardy, thrives in most soils	Disease: attacked by bacteria, fungi, viruses



Activity 1. ALIENS MOVING IN NEXT DOOR *(continued)*

3. Discuss limiting factors and ask students to predict each chosen plant's population growth in the schoolyard.
4. Ask the same small groups to create and name an imaginary exotic plant species. Have them chart biotic potential and environmental resistance and draw a picture of the exotic plant.
5. Describe how the imaginary species would get into each chosen plant's ecosystem, and based on its biotic potential and environmental resistance, discuss ways in which people could control the plant's spread.
6. Hand out a reading on purple loosestrife (see page 7, for example). Read and discuss its identifying characteristics and how it arrived and spread in North America. List the biotic potential and environmental resistance of purple loosestrife on a chart similar to the "quack grass" example.
7. Work with students to formulate several hypotheses about the impact of purple loosestrife on an ecosystem. Ask students to defend the hypotheses with information about biotic potential and environmental resistance. Compare the hypotheses to the scenarios developed by the class for schoolyard plants.

BACKGROUND INFORMATION

Each organism shares its ecosystem with other organisms (biotics) that affect its ability to survive. The physical, non-living environment (abiotics) also affects the survival of organisms. At all times, the interplay of biotic and abiotic factors in the environment limits the growth and reproduction of individual organisms. We refer to an organism's push to grow and fill the environment with its offspring as its biotic potential. Some of the factors that increase the organism's biotic potential include high growth and reproductive rates, a good ability to migrate and invade new habitats, strong defense mechanisms, hardiness, and an overall ability to cope with adverse conditions (adaptability). Factors that offer environmental resistance (i.e. limiting factors that decrease the likelihood of survival or reproduction) include insufficient water or nutrients, unsuitable habitat, adverse weather conditions, predators, disease, competition for growth requirements, etc.

Ecosystems become more diverse and more stable as they evolve. The organisms within each ecosystem achieve a dynamic balance – each is connected to and dependent upon the others. Each organism's biotic potential interacts with its environmental resistance to keep its respective population in balance. This balance is dynamic; it changes over time. If some of the interactions are lost, if the balance is upset, the web of connections may begin to unravel.

Activity 1. ALIENS MOVING IN NEXT DOOR

D. BLUMER

Purple loosestrife may have a greater biotic potential or less environmental resistance than the native plant species with which it competes.

As people have traveled from place to place, they have altered the environment and carried along, sometimes intentionally and other times accidentally, species of plants and animals not indigenous (native) to a region. These organisms are called introduced, non-native, or exotic species. Many introduced species never become established in the wild (naturalized) and their populations simply collapse within a generation or two. Successful invaders (invasive species), however, upset the balance of native ecosystems by permanently altering the environmental resistance for other species. When an invasive, exotic species invades an ecosystem, it may have a much greater biotic potential or significantly less environmental resistance than what the native species possess. When an exotic species has no predators to control it, it may outcompete indigenous organisms for space, nutrients, water, etc. The exotic species may be able to reproduce more successfully than local species. In this way, exotic species sometimes displace native species. To maintain the health of native ecosystems and be able to make informed personal and community choices, it is important to be aware of the impact exotic species (e.g., purple loosestrife, zebra mussel, sea lamprey, spotted knapweed, and round goby) can have on an ecosystem.

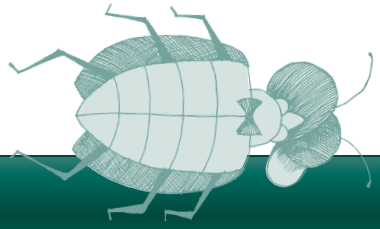
STUDENT ASSESSMENT

The following things can be considered when assessing student performance:

- Charts of biotic potential and environmental resistance.
- Drawing of imaginary exotic plant species.
- The biotic and abiotic limits to growth, biotic potential, and environmental resistance identified for the chosen schoolyard plant, imaginary exotic plant, and purple loosestrife.

EXTENSIONS

Students can draw a web showing interactions between their imaginary plant and its ecosystem. They can predict the population growth of their imaginary plant relative to other organisms in the web.



Activity 1. ALIENS MOVING IN NEXT DOOR *(continued)*

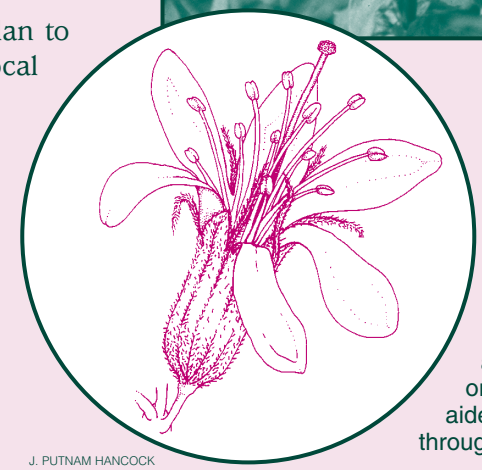
Students can create a biological control for their imaginary plant. Biological control is the use of one organism to control another. Have students list characteristics of the biological control species and describe how the imaginary plant will be controlled without harming the environment.

Ask students, as scientists, if they were to observe an increase in purple loosestrife over the next several years, what inferences would they make? Using the Internet, have them gather information on the spread of purple loosestrife over the last 100 years. Describe how their inferences compare to the historical record.

Interview people living in the area where there is a purple loosestrife infestation. Find out what they remember about the plant. How long has it been there? How fast have the numbers increased? Have they seen anything eating the plant?

Have students create an action plan to control purple loosestrife in a local wetland.

WISCONSIN WETLANDS ASSOCIATION



J. PUTNAM HANCOCK

Large purple flowerheads (inflorescence) have made purple loosestrife an attractive ornamental and aided its spread through commerce.

*Revised with permission from "Aliens Among Us," in *The Purple Loosestrife Project: Cooperator's Handbook*.

The Biology of Purple Loosestrife**

A herbaceous perennial wetland plant, purple loosestrife (*Lythrum salicaria*) is native to Eurasia. It was probably introduced to North America in the early 1800s via ship ballast and for use as a medicinal herb and ornamental plant. Infestation of native habitat has been increasing exponentially since 1880 (Thompson, et al. 1987). From 1940 to 1980, the rate of spread was approximately 1.5 latitude-longitude blocks per year. The plant is now (1995) established in each of the 48 contiguous states with the possible exception of Florida. The greatest concentrations are in the New England, mid-Atlantic Coast, and Great Lakes States.

About 35 species of *Lythrum* are known throughout the world. Twelve species are now recognized as occurring in the United States, three of which are exotics (including purple loosestrife). In addition, the horticulture industry has propagated numerous cultivars of purple loosestrife, some of which are capable of sexual and asexual reproduction and therefore contribute to the spread and diversity of the plant in the wild (Welling and Becker 1992).

Thompson, et al. (1987) described the optimum habitats for purple loosestrife in the eastern and central United States as "freshwater marshes, open stream margins, and alluvial floodplain." Light intensity appears to be critical to the growth of purple loosestrife as the plant is most vigorous at 100 percent light and exhibits reduced production at light levels below 50 percent (i.e. shaded sites). The plant is often associated with cattails (*Typha* sp.), reed canarygrass (*Phalaris arundinacea*), and other moist-soil plants.

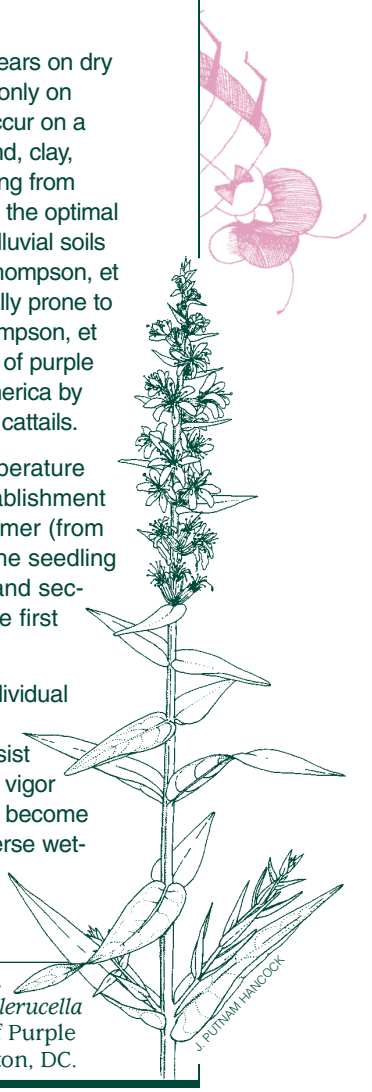
Purple loosestrife grows from 1.5 to 9 feet high with individual plants as wide as 5 feet at the top. Up to 30-50 annual stems can emerge from a single rootstock. The leaves are opposite and lanceolate. The large reddish-purple flowerheads occur in the axils of the tight upper leaves and are easily recognizable from late June to early September. In early autumn the leaves of the plant go through a dramatic but brief color change from green to bright red with the bright red color lasting for up to 10 days. The dead stems generally remain standing through the winter.

Mature plants can produce 1,000 seed capsules per stem with approximately 90 minute seeds per capsule, for about 2,700,000 seeds annually per plant (Thompson, et al. 1987). It has been estimated that a 1-acre stand of purple loosestrife can produce up to 24 billion seeds. Seed dispersal seems to occur mainly by water movement although wind dispersal may move seeds several yards from the parent plant. Animals and humans may also spread the seeds. The plant does not appear to be capable of spreading by rhizomes.

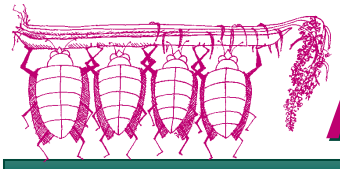
Although mature plants can persist for years on dry sites, seedlings become established only on moist soil sites. Establishment can occur on a variety of substrates (e.g., gravel, sand, clay, organic) and with soil pH levels ranging from acidic (4.0) to alkaline (9.1), although the optimal substrate seems to be organic and alluvial soils with a neutral to slightly acidic pH (Thompson, et al. 1987). Disturbed sites are especially prone to purple loosestrife establishment. Thompson, et al. (1987) speculated that the spread of purple loosestrife may be aided in North America by the foraging activities of muskrats on cattails.

Seed germination occurs within a temperature range of 59° to 68° F. Seedling establishment occurs in late spring and early summer (from over-wintering seeds). By 20 days the seedling is about 1.5 inches tall, the lateral and secondary roots are developed, and the first leaves appear.

Little is known about the longevity of individual purple loosestrife plants. However, stands of the plant are known to persist for decades with no apparent loss of vigor (Thompson, et al. 1987). Stands can become extensive, essentially converting diverse wetland communities to monospecific loosestrife communities.

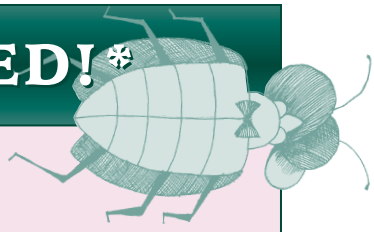


** Excerpted from "Appendix 1: Biology of Purple Loosestrife" In U.S. Fish and Wildlife Service. 1995. Environmental Assessment of Proposed Release of Three Non-Indigenous Insects, *Galerucella calmariensis*, *Galerucella pusilla*, and *Hylobius tansversovittatus,* for the Biological Control of Purple Loosestrife (*Lythrum salicaria*). Division of Refuges, U.S. Fish and Wildlife Service, Washington, DC.



ACTIVITY 2 GRADES 6-12

INVASIVES EXPOSED!*



Objectives

➡ **Students will learn the name(s) and identifying characteristics of invasive plants.**

➡ **Students will present or display their projects.**

➡ **Students will demonstrate their creative abilities.**

Time Requirement

2 class periods and 2 weeks for students to complete assignment.

Wisconsin Model Environmental Education and Science Standards

Environmental Education: **A.8.6, A.12.5, B.12.5, E.12.3.** ***Science:*** **A.8.1, A.8.6, B.8.6, F.8.9, G.8.5, F.12.7, F.12.8, G.12.5, H.12.1, H.12.4.**

DESCRIPTION

Students create an invasive plant display using a variety of possible methods of presenting the material, such as posters, plant mounts, computer-aided image projections, pictures, videos, slide shows, etc.

PROBLEM

What invasive plants are in our school district?

MATERIALS

- ❑ Pictures and/or samples of plants.
- ❑ Art supplies for different media.
- ❑ Audio/visual equipment, if necessary.

PREPARATION

The teacher should determine which invasive plants are in the school district.

PROCEDURES

1. Have students conduct research on invasive plants in their district.
2. Ask students to communicate what they learn to their classmates and community via posters, displays, or audiovisual presentations.

BACKGROUND INFORMATION

It is important for citizens to be able to recognize native and non-native plants through their characteristics, such as leaf shape, size, and placement. Visual displays help focus attention on these attributes. Also, invasive plants often dramatically change how Wisconsin plant communities look, in addition to affecting how they function. Students should begin to recognize such changes and decide how they feel about them visually, aesthetically, and ethically, as well as ecologically.

STUDENT ASSESSMENT

Students should be assessed on the information they present and the quality of their display or presentation. The information should include an identifiable description of the plant, history and current location, why it is a problem, and how one would control it.

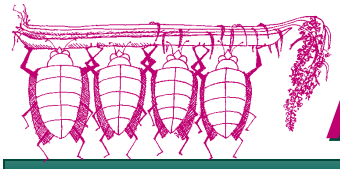
Activity 2. INVASIVES EXPOSED!

EXTENSIONS

Have students alert the public about the problems that are resulting from particular plants and persuade people to help in local control efforts.

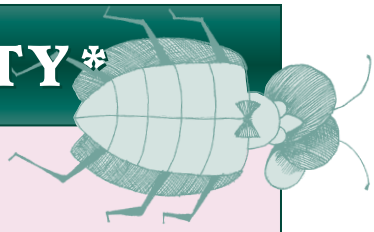
Some student displays could focus on comparing Wisconsin plant communities with and without non-native species. Wetlands look very different with and without large patches of purple loosestrife. Similarly, prairies change visibly when sweet clover, leafy spurge, or non-native grasses begin to dominate.

* Revised with permission from "Invasive Weed Display" in *Project W.U.L.P.: Wetland Understanding Leading to Protection*.



ACTIVITY 3 GRADES 6-12

BEAN BIODIVERSITY*



Objectives

- Students will be familiar with the concept of biological diversity (biodiversity) and why it is important.
- Students will describe how diversity can be measured and expressed with a mathematical index.
- Students will understand how useful a non-biological model can be in describing biological processes.
- Students will understand the effect an invasive species such as purple loosestrife can have on diversity in the biological community it invades.

Time Requirement

45-minutes.

Wisconsin Model Environmental Education and Science Standards

Environmental Education: A.8.1, A.8.4, A.8.5, A.8.3, B.8.3, C.8.2, D.8.6, A.12.1, B.12.3, B.12.6, B.12.7. *Science:* C.8.2, C.8.3, C.8.11, F.8.8, F.8.9, C.12.4, C.12.5.

DESCRIPTION

Students use an index model to assign numerical values to the biological diversity of a given habitat.

PROBLEM

How can various biotic communities (or a community changing over time) be compared in terms of biological diversity?

MATERIALS

(To be distributed to each student or each small group)

- ❑ Several assorted, dry seeds (beans).
- ❑ Paper lunch bags.

PREPARATION

Prepare one bag with assorted seeds for each group or for each group of students. Each bag should contain 30 seeds of at least five different kinds. Read and discuss the background information with the students.

PROCEDURES

1. Each student or small group should get a paper bag of assorted seeds.
2. Assign a wetland plant name to each seed type, making sure to name one of the seeds purple loosestrife.
3. Ask students to begin removing seeds from their habitat bag, randomly, one at a time. Using letter symbols for wetland plant names, record your results. Remove 30 seeds. Results should look something like this: LLCCSJJL…
4. Have students calculate the Diversity Index of their habitat bag and record the number.

   Diversity Index = (number of runs) / total number of plants

   The number of runs is the number of groups of the same plant found consecutively in your random drawing. Another way of stating the number of runs is that it is equal to the number of times that you encounter a change in the kind of plant

Activity 3. BEAN BIODIVERSITY

seed as you move through the sequence. In order to determine the number of runs, draw a line above or below, in alternating fashion, each identical letter that appears consecutively, like this:

L̲L̲C̅C̅S̲J̅J̅L̲

In this example there are 5 runs for 8 plants. Diversity Index = 5/8 = 0.625

5. Each small group should be given additional purple loosestrife seeds. For every purple loosestrife seed added, randomly remove one of the other seeds, mimicking the displacement that is said to occur when purple loosestrife invades.

6. Repeat steps 3 and 4.

BACKGROUND INFORMATION

One of the major problems with the increase of purple loosestrife in North American wetlands, often cited by researchers and resource managers, is that it tends to crowd out other native wetland plants. If this happens, loosestrife becomes more important in the functioning of the community and many kinds of plants it replaces become less important in the system. Gradually the number of different kinds of plants in the wetland will fall as some of the least common or most sensitive native species are eliminated by the spreading loosestrife. The "diversity" of plants in the wetland is said to decline as there are more loosestrife plants, fewer native species, and smaller numbers of the native species remaining in the wetland overall.

As plant diversity declines, the variety of available food for herbivores goes down, the kinds of places for wetland birds to nest declines, and so on. Consequently, the number and types of herbivores and birds and other animals dependent on native plants is reduced and the whole wetland community becomes less diverse. In extreme cases of very low biological diversity a wetland may become a "biological desert" (not unlike the bluegrass lawns around many of our homes). What do you think this expression means?

Biodiversity in a biotic community is a measure of both the number of kinds of organisms, as well as how evenly distributed the importance of each species is in the community. It is a significant ecological concept because a diverse community is thought to be more stable and resistant to degradation in spite of a changing world around it. Why do you think this is important today?

If it is true that purple loosestrife replaces wetland plants, and we have an accurate way of measuring and comparing diversity in wetlands over space or time, students should see a strong negative effect (correlation) of increasing levels of purple loosestrife density on the diversity index. If the expected relationship does not appear, it may not be true, or further research or refinement of techniques or calculations may be necessary.

Activity 3. BEAN BIODIVERSITY *(continued)*

PHOTOS: WISCONSIN WETLANDS ASSOCIATION

Healthy wetlands support diverse plant and animal communities like the ones shown here.

This activity uses a simple, non-biological model to measure diversity by calculating a mathematical diversity index for a group of items. It also allows us to see what happens as one of the items becomes more common in the group and the others less common. This mimics what would happen if purple loosestrife were indeed to replace other plants in a wetland. The number of runs (see procedures) is a measure of both how many different types of organisms there are, as well as the relative numbers of each, for a given number of organisms counted (sample size). The closer the diversity index is to 1, the more diverse the community is. Simply put, the more different kinds of species there are and the more even in number they are, the greater the diversity. Bear in mind that the number of items counted should be similar to be able to compare different communities in either space or time.

Activity 3. BEAN BIODIVERSITY

STUDENT ASSESSMENT

Have students write a lab report stating the problem, a hypothesis, experimental procedures, observations, analysis and conclusions. They should include a discussion of how well the model mimics what can happen in a wetland community as purple loosestrife invades.

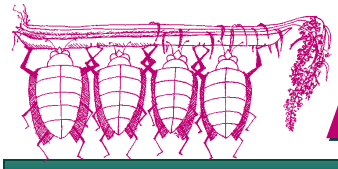
EXTENSIONS

Re-work your calculations, excluding purple loosestrife runs (the increasing item) from the numerator of the diversity index. This will give you a measure of the effective diversity of only native plants. Is the resulting diversity index higher or lower than when you included loosestrife? Why? One might argue that this might be a more meaningful measure of plant diversity in native wetlands. Why is this so? Which means of calculating diversity is most meaningful for you? Why?

Sample the diversity in real wetlands. Tie a cord (transect line) to two posts put into the ground 3 meters apart in a wetland. Instead of randomly drawing seeds out of a bag, record the species identity of each plant as it is encountered along (under) the transect line. Calculate the Diversity Index for the wetland. Walk transects at several randomly chosen spots, being sure to use the same number of counted individuals each time. Does each transect give the same index value? Why or why not? Average them for a good overall value. (See also Activity 11. Wetlands on the Mend)

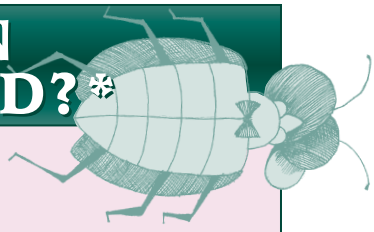
Using the information from the transects or model, determine the percent of each plant species encountered in each wetland by dividing the number of individuals of one species by the total number of individuals counted. This is a Species Diversity Index. Do you think it is more or less precise than the Diversity Index we calculated above? Show your results in a bar graph.

[*] Revised with permission from "The Spice of Life: Assessing Species Diversity" in *Biodiversity, Wetlands, and Biocontrol* and "Annual Wetland Plant Diversity Survey" in *The Purple Loosestrife Project: Cooperator's Handbook*.



ACTIVITY 4 GRADES 6-12

IS OUR SCHOOL IN LOOSESTRIFE LAND?



Objective

➡ **Students will locate and map the area where they attend school, showing any presence of purple loosestrife.** *(Students can map other invasive wetland plants if no purple loosestrife occurs in your area.)*

Time Requirement

1 initial class period and later time to review homework.

Wisconsin Model Environmental Education and Science Standards

Environmental Education: **A.4.1, A.4.2, A.8.4, C.8.2, E.12.3.**
***Science*: C.8.8.**

DESCRIPTION

Students locate stands of purple loosestrife near their school.

PROBLEM

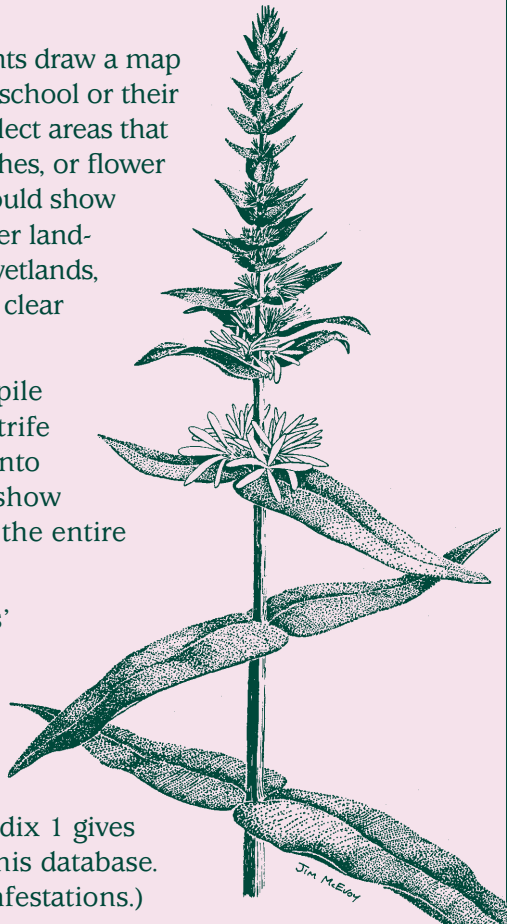
Is purple loosestrife a problem in our area?

MATERIALS

- ❑ Drafting supplies: rulers, pens, pencils, drawing paper.
- ❑ Local area maps, drawn to different scales. County plat maps, U.S.G.S. topographic maps, and the *Wisconsin Atlas and Gazetteer* (Yarmouth, Maine: DeLorme Publishing) are recommended. You can produce custom maps from the DNRs on-line mapping site (**http://gomapout.dnr.state.wi.us/dnrwebview/**)
- ❑ Pictures of purple loosestrife and other look-alike plants.

PROCEDURES

1. Have each pair of students draw a map of a small area near the school or their homes, taking care to select areas that have wetlands, road ditches, or flower gardens. Their maps should show roads, buildings and other landmarks, waterways and wetlands, purple loosestrife, and a clear scale and legend.
2. Have the students compile all of the purple loosestrife data from their maps onto at least two maps that show the collective area that the entire class surveyed.
3. Compare your students' results with the data that are posted on the map that you can view at **http://www.glifwc-maps.org** (Note: Appendix 1 gives instructions for using this database. Please report all new infestations.)



Activity 4. IS OUR SCHOOL IN LOOSESTRIFE LAND?

R. QUEEN

D. BLUMER

Purple loosestrife often can be found near our homes and schools. Mapping the location of loosestrife raises awareness of this invasive plant.

4. Assign the students to contact the landowners in places where purple loosestrife is growing on their property. Have them provide landowners with information about this invasive exotic species. **Note:** Use caution regarding asking young students to contact landowners regarding their land.

BACKGROUND INFORMATION

Appendix 1 contains a map of Wisconsin from a mid-1980s purple loosestrife survey. This map provides a general idea about where purple loosestrife is the most serious problem in the state. The appendix also includes instructions on how to access a website that identifies most known purple loosestrife locations in the state. Many purple loosestrife sites remain unknown, but these resources show how ubiquitous the plant is around Wisconsin.

It is critical that someone in every area learn about where the plant is invading wetlands. That's a project you and students can undertake that would be both a great exercise in mapping and useful in local management. In fact, any sites you locate can and should be added to the website database. Knowing about your sites also lays groundwork for local control efforts, which you can begin by rearing and releasing biological control beetles with your students.

STUDENT ASSESSMENT

Evaluate the students' drawings by making sure that each map has a clear scale and legend that includes each type of feature shown on the map. Evaluate each drawings accuracy by comparing it to the professional maps that the class uses.

Have students use the scales on the different maps to estimate how far away from the school or their homes purple loosestrife is growing.

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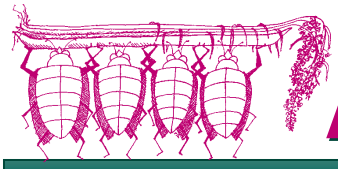
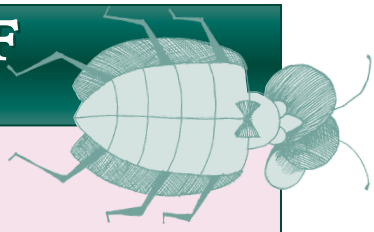
* Revised with permission from "Is Purple Loosestrife a Problem Near Our School?" in *The Purple Loosestrife Project Cooperator's Handbook*.



ACTIVITY 5 GRADES 7-12

HEY YOU! GET OFF OF MY GROUND!*



Objective

➡ **Students will perform a controlled experiment to determine what plants use allelopathy to boost their chances of success.**

Time Requirement

1 class period for setup, 5 minutes per day for 3 weeks.

Wisconsin Model Environmental Education and Science Standards

Environmental Education: **A.8.2, A.8.4, A.12.4.** ***Science*****: 1.8.6, C.8.1-7, C.8.11, C.12.1, C.12.3, F.8.8, F.12.7.**

R. QUEEN

DESCRIPTION

Students test for the effect of plant extracts on the germination of seeds.

PROBLEM

Does purple loosestrife produce chemicals that repel or kill other plants?

MATERIALS

- ❑ Analytical balance.
- ❑ Fresh or dried plant material (preferably fresh): quack grass (*Elytrigia repens*, roots and rhizomes), jimson-weed (*Datura stramonium*, roots), ragweed (*Ambrosia artimisiifolia*, roots), Canadian horseweed (*Conyza canadensis*, leaves), black walnut (*Juglans nigra*, leaves), common buckthorn (*Rhamnus cathartica*, leaves), purple loosestrife (leaves or roots).
- ❑ Per small group, 2 petri dishes.
- ❑ Box of filter paper or roll of paper towels.
- ❑ Deionized water.
- ❑ Per small group, 10 radish (or other fast germinating) seeds.
- ❑ Per small group, 1 15-cm ruler.
- ❑ Mortar and pestle.
- ❑ Pipettes.

PROCEDURES

Direct students to do the following 4 steps:

1. Weigh 10 grams or more of plant material. Add 100 mL of distilled water and grind the material of each separate kind of plant in a mortar and pestle. The mixture should be very dense and pasty. If it is too thin, add a small amount of plant material, carefully noting the mass of plant material added. Stir the mixture several times in the course of the day; it can be used the next day.

2. Assign one of the plant types to each group, and have each group label one petri dish with the name of its plant and one with "water." Then place the 5 radish seeds in a folded paper towel in the bottom of the petri dish. Measure enough plant extract onto the paper towel to soak it. Be sure the plant extract used

Activity 5. HEY YOU! GET OFF OF MY GROUND!

on the seeds matches the label on the petri dish. Place a lid on the dish and place it in the dark. Check periodically and water with extract, keeping the amount of extract used the same for all the petri dishes.

3. Record germination dates. Record the radicle and hypocotyl growth daily for approximately 5 days. Record qualitative information about the seeds. Chart qualitative results.
4. Calculate means and graph or chart quantitative results. Ask students to discuss their results and draw conclusions.

Have students view the data collected by the rest of the class and evaluate the presence or absence of allelopathy in the species that were tested. Conclude together whether purple loosestrife exhibits allelopathy.

BACKGROUND INFORMATION

Some plants produce chemicals that are harmful to other plants. This is called allelopathy. It often allows a plant to escape competition from other plants for water, soil nutrients, light, pollinators, etc. Allelopathy is most often seen where a habitat is crowded with plants needing the same resources.

The chemicals can act in different ways, such as retarding other plants' seed germination, slowing their growth, or even poisoning them. The varied plants listed in the materials section are all examples of allelopathic species, except purple loosestrife—maybe. Actually, since purple loosestrife can take over a wetland so quickly, some scientists have wondered if it uses allelopathy to get ahead of its neighbors. This study gives students a chance to test just that!

STUDENT ASSESSMENT

Have students create a written lab report with a summary of results and their implications for wetlands and purple loosestrife. Combine allelopathic information with other information on the biotic potential of purple loosestrife (see Activity 2). Measure that against any known environmental resistance. Suggest what can be done.

EXTENSIONS

Try other allelopathic interactions. For example, use double-sided tape to stick a horseweed leaf inside of the top of the petri dish, out of contact with water, paper towel, or seeds.

Try using the various extracts to water mature plants.

Go on-line and find the results of other scientists' investigation into allelopathic interactions.

Have students create a visual representation of their findings.

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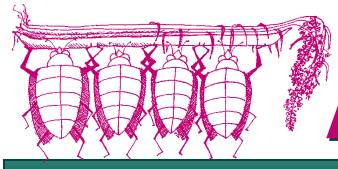
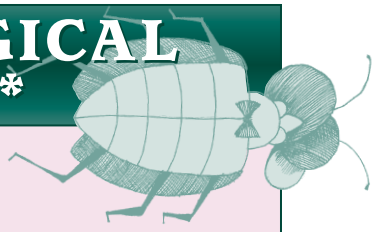
* Revised with permission from "What's Wetland Allelopathy?" in *The Purple Loosestrife Project Cooperator's Handbook*.



ACTIVITY 6 GRADES 6-12

CHOOSING BIOLOGICAL CONTROL AGENTS*



Objectives

➡ **Students will develop criteria to use when choosing biological control agents.**

➡ **Students will evaluate potential agents for use as biological control against purple loosestrife.**

Time Requirement

45 minutes.

Wisconsin Model Environmental Education and Science Standards

Environmental Education: **A.8.1, A.8.4, A.8.5, A.8.6, B.8.8, B.8.14, D.8.1, D.8.6, A.12.3, A.12.4, A.12.1, C.12.3, C.12.4, D.12.1.** ***Science*****: C.8.2, C.8.6, C.8.7, C.8.9, C.8.11, F.8.7, G.8.5, H.8.2, B.12.4, C.12.6, F.12.7, F.12.8, G.12.5, H.12.4, H.12.6.**

DESCRIPTION

Scientists who conduct biological control programs for a pest must first choose appropriate control agents, typically, the pest's natural enemies. Biologists must then decide whether or not these agents are safe for importation and likely to be effective. This activity simulates this process with actual examples from the purple loosestrife biological control program.

PROBLEM

How do scientists develop and apply the criteria with which to choose natural enemies for use in biological control programs?

MATERIALS

- ❑ Copies of student handout "Rules for Selecting and Releasing Biological Control Organisms," (page 21).
- ❑ Copies of student handout "Candidates for Biological Control and their Characteristics," (pages 22-23).

PROCEDURES

1. Divide the class into teams of three. Each team should brainstorm a list of rules to be used when choosing biological controls.
2. Distribute copies of the student handout, "Rules for Selecting and Releasing Biological Control Organisms."
3. Using the handout, edit or modify the lists of rules for picking a biological control.
4. Use the handout "Candidates for Biological Control and Their Characteristics" to categorize each insect as acceptable or unacceptable biological controls for purple loosestrife. Have students rank the top five control agents and justify their choices.

Collect class data and come to a consensus on rules and the top five biological control choices for purple loosestrife.

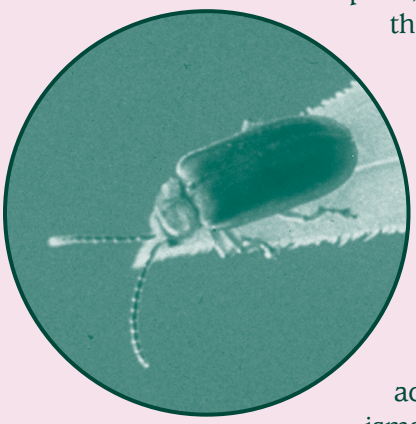
BACKGROUND INFORMATION

Biological control is the process of using one organism to control another that has become a pest. A pest is often an organism from another region that has become a problem because it was imported (often accidentally) without its natural enemies. An

introduced pest's natural enemies can be imported from their native region to help establish a balance between the pest and its enemies in the newly occupied territory. This must be done with care, however, and requires much research and analysis to be sure the imported enemies will not themselves become pests in the new region, perhaps even worse than the pest they are introduced to control.

Natural enemies, such as predators, parasites, and diseases, can all be used to help control pest species. A pest's natural enemies will be found in its native home. If the pest is an exotic, that is, has been introduced from another remote region, its natural enemies must be found there. Such enemies are usually the best for biological control because they are already well adapted for feeding on the pest and, if carefully chosen, are unlikely to feed on other species in the new region. If such a control species can be found, large numbers of these enemies can be released. Doing this could both be environmentally safe to use and make the pest less competitive in its new habitat.

In natural biological communities, such as wetlands, well-chosen natural enemies should help native species compete more effectively with exotic pests, such as purple loosestrife, and even begin to replace them. This should help preserve the diversity and quality of such areas. (Biological control can also be used in agricultural settings.)

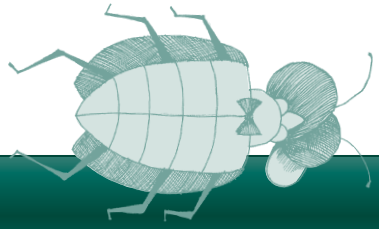


PHOTOS:
CORNELL UNIVERSITY

Some predators from a pest species' native region can be used as effective biological controls in the pest's new environment.

Few organisms native to the new country are selected as biological control agents for an exotic pest because they are not usually well adapted to feeding on the pest species and are, of course, capable of feeding on other native organisms. Native control organisms would probably have to be produced in larger numbers than the pest's natural enemies to achieve the same level of control. Native control organisms are also more likely to become pests themselves since they can shift from the exotic host to native hosts that may not be prepared for the introduced organism's unusually large numbers.

There are general rules that scientists follow in trying to find good potential biological control organisms. Any chosen control species' actual value in controlling a pest will not be known until



Activity 6. CHOOSING BIOLOGICAL CONTROL AGENTS

(continued)

it is released on or near the pest. The rules, however, make it possible to both avoid control species that will be unsafe to use and easier to find control species that will be effective and less expensive. One such list of rules is provided on the accompanying student handout. Note that the first and most important rules are ones that deal with safety. Other considerations come later. These rules must be applied with care and intelligence, erring on the side of safety.

Purple loosestrife is native to Europe and Asia. Therefore, its control organisms are most likely to come from there. In the 1980s, the search for potential control organisms was begun throughout Europe and over 100 different species of insects were found that feed on purple loosestrife. This number was initially reduced to six, then to five, by applying the rules discussed above. Finally, only four of these have since been introduced to North America, starting in 1992, because an additional problem was detected in one species while in pre-release quarantine here. Care must constantly be exercised. Additional monitoring of all the released species continues to insure they are safe for use. Currently, released insects include both *Galerucella* beetles, *Hylobius*, and *Nanophyes marmoratus*.

We have assembled a short list of some of the insects initially studied for purple loosestrife control work, along with their characteristics that may be important in choosing safe and effective control organisms. This list is provided in the second student handout.

Since there are many generalist plant predators here in North America, some or even many will likely feed on purple loosestrife in different places and times. Some of these may even become locally abundant on the plant as they exploit an acceptable, newly found food source. This additional help in controlling loosestrife is expected. It is unlikely, however, that any native predators will be artificially reared because it is doubtful that they can sufficiently slow the increase of purple loosestrife in our wetlands and difficult to predict what problems they may cause by shifting to native hosts. Biologists, however, are always searching for new, safe, effective and inexpensive control methods. If you ever think you have found an organism that might be worthy of further study, please do not hesitate to inform us of your discovery by e-mailing **brock.woods@dnr.state.wi.us** or calling (608) 221-6349.

STUDENT ASSESSMENT

Use the following factors when assessing student performance:

- Contribution to class discussion and justification of choices.
- Ability to work with peers.
- Explanation of the importance of biological control.
- Any assigned research on past successes and failures in biological control.

[*] Revised with permission from "Choose Your Enemies Carefully!" in *Biodiversity, Wetlands, and Biological Control*.

Rules for Selecting and Releasing Biological Control Organisms

Scientists always apply rules, such as those listed below, when choosing organisms to be used for biological control.

A. Safety considerations

An organism that is to be introduced as a biological control agent for a pest must:

1. **Be very host specific, that is, prey only, or mostly, on the target pest.** If it can survive on, or even feed extensively on, other organisms it may become a pest itself. It would also be useful if it had a wide variety of predators so that its own numbers will never exceed what is necessary to control the pest.
2. **Have few, or no, other direct or indirect effects on other organisms.** For example, it must not compete in any serious way with other organisms for resources. This could allow it to harm them indirectly or even attack them. An example is the multi-colored Asian lady beetle here in Wisconsin that, in addition to eating more than the initial target pest (aphids,) also collects in large numbers in people's houses in fall—space competition with us!
3. **Not harbor internal parasites or pathogens that would be unwise to import.**

B. Effectiveness and cost considerations

An organism that is to be introduced as a biological control agent for a pest should:

4. **Come from a climate and biological community similar to those into which it will be introduced.** It must be able to tolerate temperature, seasons, level of moisture, etc. in the new country. For example, a control agent for a pest of citrus trees must be able to withstand the high heat of most citrus-growing areas in the United States. An insect that required an extended cold period (winter) to complete its development would not be a suitable candidate.
5. **Be common and easy to capture.** Large numbers of them will likely be necessary and if they are common and easy to get, collecting many should neither harm populations in the home country, nor be difficult and expensive.
6. **Be easy to raise and release in large numbers and/or have a high reproductive potential in its new home.** Again, most programs will need millions of individuals. Usually, large numbers must be propagated and released cheaply, or a released few must increase rapidly on their own after release, or both. If neither works, either it will not control the pest or costs will be too high. Large-scale releases are usually the best way to ensure that enough males and females (in the case of larger organisms) find each other to mate and reproduce in their new home. However, high reproductive potential may be as effective and cost less, especially with good natural dispersal. For example, a few cheaply produced individuals of a disease-causing organism that reproduces rapidly may spread quickly causing a wide-scale outbreak of the disease in the pest.
7. **Have broad tolerances to withstand rigors of shipping, etc**. It must survive to be useful. Costs will be high if special care has to be taken during shipping, propagation, etc.
8. **Be able to escape predation until numbers exceed what is needed to control the pest.** This is a complex ecological consideration. See Point 1 above.
9. **Be able to disperse once released.** Pests may be spread out, hard to find or get to and it may otherwise be hard or very expensive to get control agents to them.
10. **Be suitable for combining with other potential control organisms to maximize control effect.** Multiple attack points on the target pest, minimal competition among control agents, etc. should all be considered.
11. **Be able to remain in the new country at a low level, without problems, ready to attack the pest whenever necessary.** Pest outbreaks will likely occur periodically …

Candidates for Biological Control and their Characteristics

SCIENTIFIC NAME	TYPE OF INSECT	LOCATION	PLANT PART	ABUNDANCE	TOLERANCE
Nanophyes	**Flower Weevils**				
annulatus		W. Europe	Stem, leaf	High	Low
circumscriptus		N. and C. Europe	Stem, leaf	Very low	High
globiformis		S. and C. Europe	Stem	?	?
helveticus		S. and C. Europe	Stem	Low	Medium
marmoratus		Widespread	Seeds	High	High
brevis		S. Europe	Seeds	Medium-high	High
nitidulus		S. and C. Europe	Stem	?	High
Coleophora	**Case Moths**				
paripennella		Europe	Leaf	Medium	High
Galerucella	**Leaf Beetles**				
pusilla		Widespread	Leaf, stem	High	High
calmariensis		Widespread	Leaf, stem	High	High
Lygus	**Leaf Bugs**				
pratensis		N. Yugoslavia	Leaf	?	High
Hylobius	**Root Weevils**				
transverovittatus		Widespread E. Austria	Root	Low	Medium
Ametastegia	**Sawflies**				
glabrata		N. America	Leaf	High	High
Adelphocoris	**Plant Bugs**				
seticornis		N. Yugoslavia	Leaf	High	High
Acleris	**Noctuid Moths**				
lorquinainae		W. Europe	Flower	Very low	Medium
Philaenus	**Spittlebugs**				
spumarius		Widespread	Stem, leaf, flower	High	Low
Deilephila	**Sphinx Moths**				
paludella		E. Austria	Leaf	High	Medium
Dasineura	**Midges**				
salicariae		Widespread	Stem, buds	High	High
Taeniothrips	**Thrips**				
discolor		Widespread	Flower	High	High
Aphthona	**Beetles**	E. Austria			
lutescens		N. Italy	Roots	High	Medium

LOOSESTRIFE SPECIFIC	LOOSESTRIFE EFFECT	PARASITES	FECUNDITY	MISCELLANEOUS COMMENTS
?	High on stems	No	Low	Hard to catch
Yes	?	No	Low	
Yes	?	No	Low	Mines the stems
Yes	?	No	Low	
Yes	80% destruction	No	Medium	
Yes		Nematode	Medium	
On *Lythrum hyssopifolia*	40%	No	Medium	
No	?	No	High	Mines the leaves
Yes	80% leaves	No	High	Up to 4 generations/ year if warm
Yes	80% leaves	No	High	
No	?	No	High	
Yes	High on roots	No	High	Long lived
No	Medium	No	High	
Eats legumes	?	No	High	
Yes	?	No	Low	Easy to attract and catch
No	Damages whole plant	No	Medium	Easy to catch
No	Often high local damage	No	Medium	
Yes	75% seed 80% leaves	Parasitic wasp	High	
No	50% flowers destroyed	No	High	
Yes	Effective	No	Medium	Kills other insects' eggs

NOTES:

Scientific name—Capitalized name is the genus for insect species below it. Lower case names are species of the genus above them. Scientific names include both genus and species.

Plant Part—Most commonly attacked part of purple loosestrife.

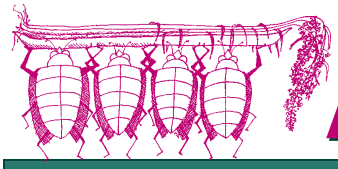
Abundance—Number of insect individuals encountered where it is found.

Tolerance—Ability of insect to be manipulated, e.g., grown in captivity.

Loosestrife specific—Does insect live only on loosestrife? (Some alternate hosts listed.)

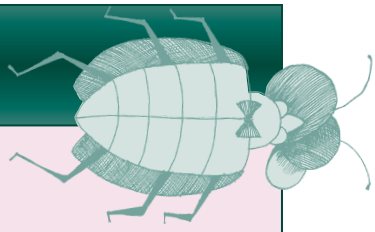
Parasites—Does the insect have parasites or other companion organisms hard to separate from it?

Fecundity = Number of offspring the insect produces/time



ACTIVITY 7 GRADES 7-12

BEETLE SMORGASBORD*



Objectives

➡ **Students will apply the scientific method.**

➡ **Students will perform an experiment on various plant and beetle associations.**

➡ **Students will determine surface area (and biomass) differences and analyze data.**

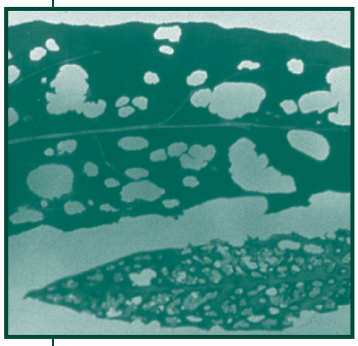
➡ **Students will help determine how safe *Galerucella* beetles are as an alien species.**

Time Requirement

2-3 class periods.

Wisconsin Model Environmental Education and Science Standards

***Environmental Education:* A.8.2, A.8.4, A.8.5, B.8.8. *Science*: C.8.2, C.8.5, C.8.6, F.8.8, C.12.3, F.12.8.**



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Typical *Galerucella* feeding damage.

DESCRIPTION

Students compare feeding behavior of *Galerucella* beetles on a variety of plants that include house plants, farm produce, farm crops, landscape plants, forest plants, or related species in wetlands.

PROBLEM

Do *Galerucella* beetles feed on any plants other than purple loosestrife?

MATERIALS

- ❑ Copies of student handout, "Experimental Procedures," (page 26).
- ❑ Copies of student handout, "Lab Report," (pages 27-28).
- ❑ 1 per student, 1 mm-square graph paper for lab data.
- ❑ Per team, 1 Stereoscope, 4-10-power magnification or magnifying lenses.
- ❑ Analytical balance (optional, for activity extension).
- ❑ 1 per team, 15-cm diameter petri dish with cover and appropriately sized filter paper.
- ❑ 1 roll write-on cellophane tape.
- ❑ 1 pencil.
- ❑ 15-cm ruler.
- ❑ Scissors.
- ❑ 5 per team, *Galerucella* beetles, stored in vial until used.
- ❑ Aspirator for moving or catching beetles.
- ❑ 1 per team, purple loosestrife leaf.
- ❑ 3 per team, similarly sized leaves of different plant species.
- ❑ 1 per team, 250-mL beaker with 200 mL water at room temperature.
- ❑ Sink for additional water and disposal of used water.
- ❑ Distilled water, if possible, for wetting filter paper.

PREPARATION

One day to one week before the activity, teacher and/or students bring in 6-8 leaves from known species of plants including purple loosestrife. Keep these in refrigerated sealed plastic bags.

With students, categorize where each species of leaf should be placed (houseplant, farm produce, farm crop, landscape plant, forest plant, wetland plant).

Activity 7. BEETLE SMORGASBORD

Obtain through purchase, or field-collect from a wild source (easiest in late spring), the necessary *Galerucella* beetles. Using an aspirator, place 5 beetles in a vial for each student team.

PROCEDURES

1. Have students follow directions on "Experimental Procedures" handout.
2. Discuss these questions related to experimental conclusions with the class:
   - During the procedures, why were you asked to clean and wipe the scissors between cuttings of each plant species?
   - Why did we cut each leaf into equal sized pieces?
   - List the plant species used by beetles for feeding.
   - What conclusions can you draw from your observations?

STUDENT ASSESSMENT

Use the following factors when assessing student performance:

- Close adherence to the experimental design and clear notes relating to observations.
- Development and explanation of conclusions that are supported by the observations.
- Accurate and careful treatment of plant species in order to preserve experimental accuracy.

EXTENSIONS

Before the students are allowed to place their plant cuttings in the petri dish, have the students measure the mass of the leaf pieces using the balance. They will then have to calculate the changes in biomass following the 24-hour feeding period by measuring the mass of the remaining leaf pieces. Be sure to set up control leaf pieces in a petri dish to which no beetles are added. Compare weight loss (if any) in controls to weight loss of leaves kept with beetles. Why might you want to subtract control weight loss from any weight loss observed with beetles before making conclusions about beetle feeding?

Before collecting plant species, consult the Wisconsin Wetlands Association's website, **http://www.wiscwetlands.org**, for a list of plant species that have undergone this type of experiment. Try to test one or more plant species that do not appear on the list of tested species, especially native species. Note that this will likely be original research! After the experiment, report your results to Wisconsin Wetlands Association for posting on the Internet by mailing a photocopy of the entire laboratory report for each tested species to WWA-Purple Loosestrife, 222 S. Hamilton St., Ste. 1, Madison, WI 53703. Then, watch WWA's website for your experimental results to be posted for the world to see!

* This activity was developed with the help of the Lake Holcombe High School Plant Science/Horticulture Teacher's *Galerucella calmariensis* Lab and Experimental Activity 1 – Biological Control.

Experimental Procedures

DAY 1

1. Get supplies from teacher.
2. Obtain one purple loosestrife leaf and one leaf of similar size from each of three different species of leaves.
3. Divide circular filter paper into quarters by drawing a pencil line through the center of the paper and another line perpendicular to the first line. Number each quarter by writing the number nearest the arc of each quarter.
4. Soak filter paper with distilled water and allow excess water to drip off. Place in petri dish.
5. Cut each leaf into 2-cm by 2-cm square pieces. Be sure to dip, rinse, and rub off scissors blades between the cutting of each new leaf species. **NOTE:** Do not contaminate the cuttings. Be sure to dump out beaker and refresh with new water between cutting each plant species. DO NOT MIX UP YOUR PIECES! Place each plant species into its own pile.
6. Place each leaf piece into a different quarter of the filter paper and record its location number on your data sheet.
7. Obtain 5 *Galerucella* beetles from teacher and place them in the center of the moistened filter paper and IMMEDIATELY cover. (Beetles can fly – DO NOT allow escapees). Be sure to record the time of release.
8. Tape cover on opposite sides of the petri dish so cover is held on firmly.
9. Print your group name on tape near outer edge of petri dish cover.
10. Document observations on data sheet.
11. Use stereoscopes or magnifying lens to observe the following: (a.) beetle movements, (b.) use of appendages, and (c.) actual feeding activities.
12. Near the end of the period of Day 1, place the petri dish in safe, well-lit area.

DAY 2

1. After the 24-hour observation period, place the leaf pieces on the 1 mm graph paper.
2. Trace the remaining leaf shapes and number them with their corresponding filter paper numbers found in their quarters.
3. Determine (estimate) the number of square millimeters of leaf missing. Remember you began with a piece that measured 2 cm on each side.
4. Figure the percent of leaf consumed by the beetles during the 24 hours of exposure to the leaves.

$$\frac{\text{Number of Square Centimeters Consumed}}{\text{Number of Total Square Centimeters before Feeding}} \times 100 = \text{Percent Consumed}$$

5. Return all beetles to the teacher.
6. Clean up the laboratory space and equipment.

Lab Report (page 1 of 2)

Group Members:

1. _____
2. _____
3. _____

Identifying Your Test Subjects:

Fill in the following chart. Write the common and scientific name for each of the four leaves your group is using. One of them must be Purple Loosestrife (*Lythrum salicaria*).

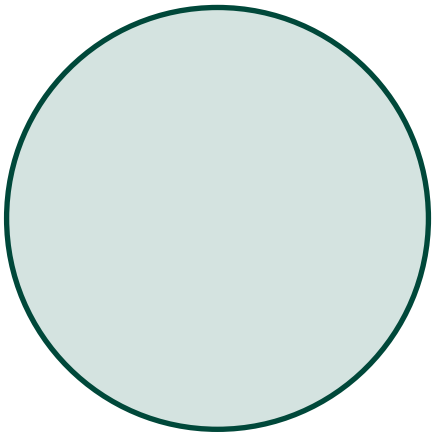
Plant Category	Plant Type	Quarter Number	Common Name	Scientific Name	Habitat
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____

Plant Categories: Houseplant, Farm Produce, Farm Crop, Landscape Plant, Forest Plant, and Wetland Plant.

Plant Types: N = Native, E = Exotic.

DAY 1 – Experimental Set Up

Show the placement of the leaf pieces in the circle below and how you marked your filter paper in the petri dish:



Lab Report (page 2 of 2)

Observations:
Draw location of each *Galerucella* sp. beetle and what type of activity has taken place:

1 minute after placing the beetles:

5 minutes after placing the beetles:

10 minutes after placing the beetles:

15 minutes after placing the beetles:

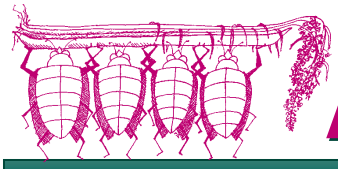
30 minutes after placing the beetles:

Conclusion (Based on the observations your group made during the lab.)

Hand in your Lab Report and place your petri dish in a well lit, safe and quiet location.

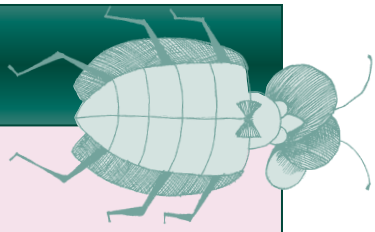
DAY 2 – 24-Hour Observation Follow-up

1. Attach your leaf tracings on the graph paper and your calculations of percent consumed for each leaf in your experiment.
2. Write a conclusion statement which links your Day 1 Observations to the Day 2 Observations and Calculations:



ACTIVITY 8 GRADES 6-12

GROWING UP IN A JAR*



Objective

➡ **Students will observe the development of a common insect through all of its life stages and compare it to the life cycle of *Galerucella* beetles and other common insects. Fruit flies and mealworms can be used because their life cycles are similar to that of *Galerucella* beetles.**

Time Requirement

Approx. 20 minutes per week, but will vary depending upon rate of insect development.

Wisconsin Model Environmental Education and Science Standards

Environmental Education: **A.8.4, A.8.5, B.12.4, B.8.12.** ***Science*****: C.8.1, C.8.2, C.8.4, C.8.3, F.8.1, F.8.2, F.8.5, F.8.6, F.8.7, A.12.6, B.12.5.**

DESCRIPTION

In order to understand the needs of *Galerucella* beetles, used to control purple loosestrife, it is necessary for students to become acquainted with its life cycle and development. Fruit flies and mealworms provide model populations that have a shorter life cycle and are often easier for students to study. They may also be used later in studying the concepts of exponential growth and limiting factors.

Students will trap adult fruit flies (*Drosophila* sp.) and describe the development from egg to adult, comparing it to that of beetles. In doing so, they will learn standard methods of handling fruit flies and may develop a colony for later study of population growth. Students can also raise mealworms (*Tenebrio* spp., available from many pet shops and easily grown in bran meal) to compare the life cycle with that of *Galerucella* beetles.

PROBLEM

What are the developmental stages and growth requirements of an insect?

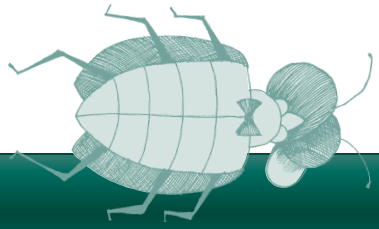
MATERIALS

- ❑ Per small group, 2 or 3 baby food jars, wide-mouthed glass vials, or 2-liter plastic bottles.
- ❑ Per small group, cotton batting.
- ❑ Per small group, cheese cloth.
- ❑ Per small group, hand lens or stereo microscope.
- ❑ Per small group, small piece of ripe banana.

PREPARATION

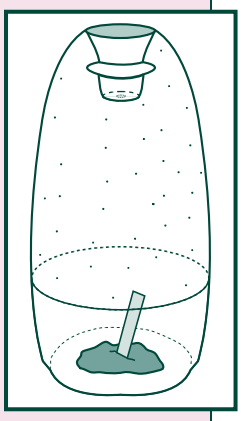
Fruit flies can be purchased from a biological supply company during winter months.

Show students insects, either by bringing some in, taking the class to an outdoor lab, or showing them pictures or a film.



Activity 8. GROWING UP IN A JAR *(continued)*

PROCEDURES



1. If you use a 2-liter bottle, students will cut the tapered portion of the bottle off at the bottom of the taper, leaving the cap on. Punch a 5-mm hole in the cap. Place ripened fruit mass in the bottom of the bottle (bananas work well). Insert a small strip of index card or heavy paper into the banana for adults to rest on and pupae to attach to. Invert the cut top and glue or tape it into place in the top of the straight portion of the bottle to form a trap. Punch pin holes on the sides.
2. Have students label their insect traps with their names and the date. Place bottles outside in a shaded location for 1 to 2 days, or until adult fruit flies are seen inside.
3. Stop the opening with a cotton ball wrapped in cheesecloth and place in a warm, shaded location of the classroom.
4. Approximately every other day, allow students time to observe the development of eggs and larvae using a hand lens or stereo microscope. These may be removed for study with a cotton swab or wooden splint. Students should make careful drawings of all stages observed, and include written descriptions of changes and behavior.
5. When adults appear, some may be transferred into another trap and inactivated for study by placing the trap in an ice bath until chilled to inactivity. As time progresses, present pictures of the life cycles of other insects, including *Galerucella* beetles. Proper terminology should be taught at this time.

Hold a discussion of students' individual observations that were made during the lab.

BACKGROUND INFORMATION

Part of successfully rearing *Galerucella* beetles for controlling purple loosestrife is recognizing the insect's life stages, of which there are four—typical of a metamorphic insect. You will also need to know the growth requirements of each stage in order to grow your beetle population quickly. With good conditions, a little luck, and 6-8 weeks, you can release 100 new beetles for every one you start with!

Studying fruit fly or mealworm life cycles will familiarize you with the growth forms of insects and prepare you for what you will see working with *Galerucella* beetles. This should make you more successful in rearing the beetles. When you are done rearing these organisms, the populations of flies and meal worms may be useful in other studies, such as population growth or genetics, while releasing the *Galerucella* beetles will, of course, help solve a serious threat to our wetlands: invasion by an aggressive, exotic plant.

Activity 8. GROWING UP IN A JAR

STUDENT ASSESSMENT

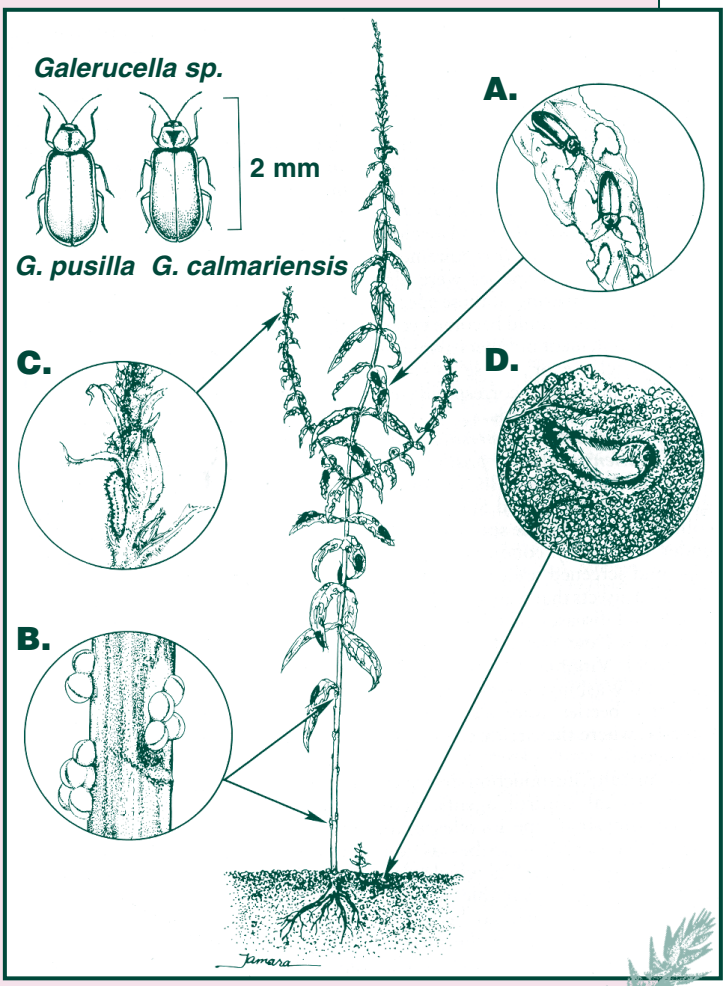
The following factors may be taken into account in evaluation of student progress:

- Accuracy of lab book drawings and quality of records of observations.
- Technique, involvement, cooperation, and interaction with group members.
- Terminology of insect development.
- Quality of presentation, if one is assigned.

EXTENSIONS

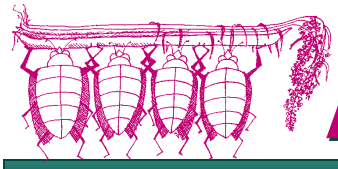
Explore your schools' surroundings for eggs of other insects, collect them and follow these insects through their life cycles. Compare and contrast them with those of fruit flies, mealworms and *Galerucella* beetles. Be sure to use suitable containers with vent holes and appropriate habitat materials. Two-liter bottles often work great. Identify and collect enough plant or animal food for the insect to complete its life cycle. Remove rotten food and release adults produced.

Have students find information about the life cycle of *Galerucella* beetles either on the Internet or in a library.



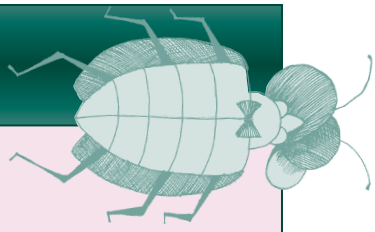
Life cycle of *Galerucella calmariensis* and *Galerucella pusilla*. A. Adults emerge in spring and feed on newly formed leaf tissue of *Lythrum salicaria*. **B.** Spring oviposition lasts approximately two months; batches of two to ten eggs are laid daily on the plant stem or in leaf axils. **C.** Developing larvae feed extensively on bud, leaf, and stem tissue. **D.** Pupation to adult occurs in the soil or litter near the host plant. Adults are short-lived, dying soon after the spring oviposition period.

* Revised with permission from "An Insect Life Cycle" in *The Purple Loosestrife Project Cooperator's Handbook*.



ACTIVITY 9 GRADES 6-12

Galerucella PREDATION*



Objective

➡ **Students will introduce various organisms into a controlled environment to determine potential *Galerucella* predators.**

Time Requirement

4-8 weeks.

Wisconsin Model Environmental Education and Science Standards

Environmental Education: **A.8.1, A.8.2, A.8.3, A.8.4, A.8.5, B.8.8, C.8.2, A.12.1, A.12.2, A.12.4, B.12.4, B.12.6.**
***Science*: A.8.1, A.8.6, B.8.3, C.8.1, C.8.2, C.8.3, C.8.5, C.8.6, C.8.11, F.8.6, F.8.8, G.8.5, A.12.3, A.12.7, B.12.4: A.8.1, A.8.6, B.8.3, C.8.1, C.8.2, C.8.3, C.8.5, C.8.6, C.8.11, F.8.6, F.8.8, G.8.5, A.12.3, A.12.7, B.12.4, C.12.1, C.12.3, F.12.7, F.12.8, G.12.2.**

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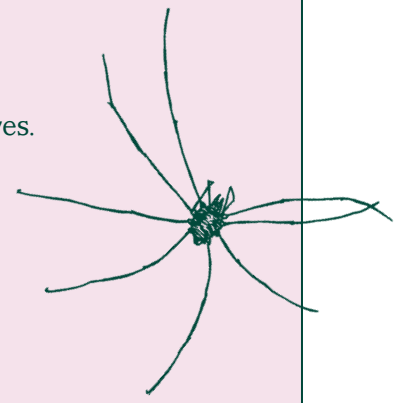
DESCRIPTION

Students conduct experiments to determine predators of and predation rates on *Galerucella* beetles.

PROBLEM

What are some of the predators that may affect the survival rate of *Galerucella* beetles.

MATERIALS



- ❑ Gallon jars or 2-liter bottles of soil.
- ❑ Purple loosestrife plant stems with leaves.
- ❑ *Galerucella* beetles.
- ❑ Various potential *Galerucella* predators.
- ❑ Clear plastic film canisters.
- ❑ Cheese cloth or netting.
- ❑ Magnifying glasses.

PREPARATION

Scout a site near your classroom where your class will be able to catch potential predators of *Galerucella* beetles.

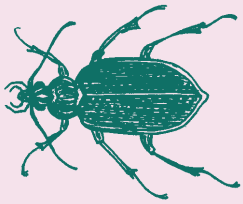
PROCEDURES

1. List potential predators of *Galerucella* beetles. Choose 5-10 predators to be collected to use in this experiment.
2. Have students set up *Galerucella* beetle habitat bottles according to the diagram.
3. Work with students to design a data table for recording observations over the planned duration of the experiment.
4. Maintain one habitat bottle with only *Galerucella* beetles as a control. Establish one habitat bottle for each chosen potential predator, putting one predator into each jar with the *Galerucella* beetles.
5. Maintain each habitat by adding fresh purple loosestrife as needed (leave old stalks in the habitat), filling the water in the canister, or replacing the predator if it perishes.
6. Have students observe each habitat bottle on a regular basis for 1-8 weeks. Record observations.

Activity 9. *Galerucella* PREDATION

BACKGROUND INFORMATION

Galerucella beetles are plant predators (herbivores). *Galerucella* beetles do not eat other animals, but there are many animals that might eat the *Galerucella* beetles. Not all of the potential predators of *Galerucella* beetles in North America are known. Biologists and resource managers need to know how these beetles will interact with other animals, especially within our wetlands, in order to predict what will happen in areas where the beetles are released. Knowing potential beetle predators also helps keep the beetles safe as they are being reared for release. *Galerucella* beetle predators may include other invertebrates (including other insects), fishes, amphibians, reptiles, birds, and mammals.



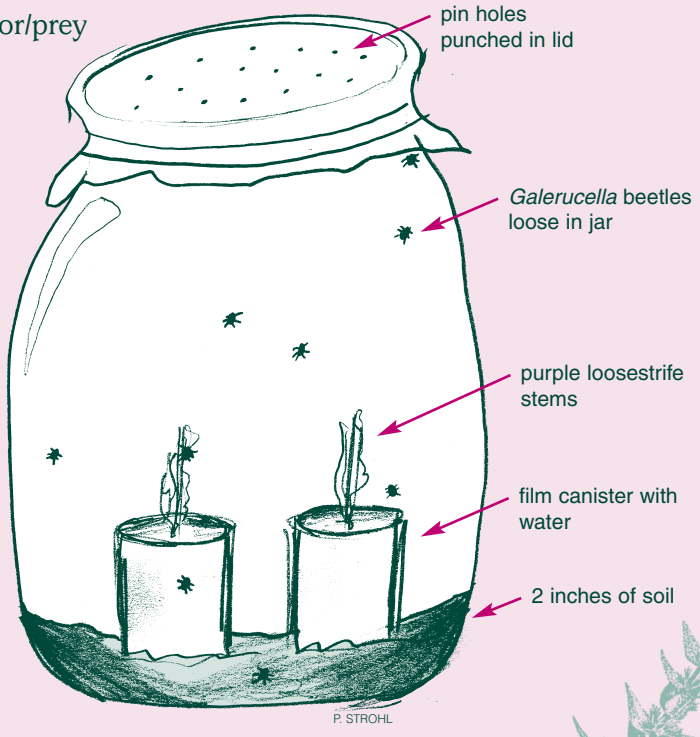
STUDENT ASSESSMENT

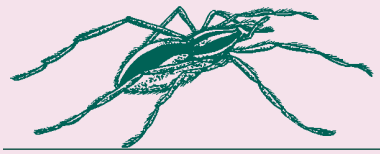
Have students write a lab report including the problem, hypothesis, experimental design, observations, and conclusions.

EXTENSIONS

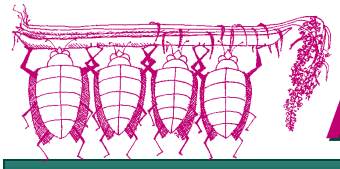
Repeat the experiment using only aquatic predators, other invertebrates, or abiotic agents (chemicals or environmental conditions).

Visit a wetland and observe predator/prey relationships on purple loosestrife at a beetle release site.



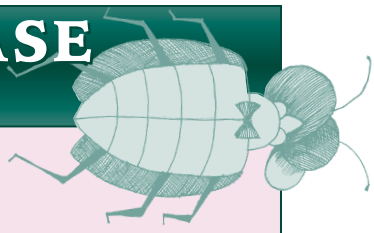


* Based on an activity developed by Catherine Werts.



ACTIVITY 10 GRADES 8-12

Galerucella RELEASE AND RETRIEVAL



Objectives

➡ **Students will determine how far *Galerucella* beetles will travel in a controlled, indoor setting to find their host food (migration).**

➡ **Students will determine factors that may cause unsuccessful migration of *Galerucella* beetles in a controlled, indoor setting (mortality/survival rates).**

➡ **Students will discuss their findings and relate them to real life factors in nature that might affect migration and mortality/survival during migration of *Galerucella* beetles.**

Time Requirement

5 minutes initially; occasional 20 minutes on an ongoing basis.

Wisconsin Model Environmental Education and Science Standards

***Environmental Education:* A.8.2, A.8.3, A.8.4, A.12.2. *Science*: F.8.6, F.12.12.**

DESCRIPTION

Students design and conduct experiments in a controlled indoor setting to study migration and mortality/survival rates during migration of *Galerucella* beetles. Beetles can be observed after release from captivity in mid-summer or during natural emergence from the ground in early spring or mid-summer.

PROBLEM

What are some of the factors that may affect beetle migration and mortality/survival rates during migration?

MATERIALS

- ❑ Live *Galerucella* beetles.
- ❑ Various potted plants, including purple loosestrife.
- ❑ Student observation notebooks.

WISCONSIN WETLANDS ASSOCIATION

Galerucella beetles actively seek out loosestrife plants, even potted plants placed throughout your classroom.

PREPARATION

If necessary, obtain permission from your principal and/or custodian to do this experiment.

PROCEDURES

1. In your classroom, set various plants around the room, including a purple loosestrife plant.
2. After school, release a predetermined number of *Galerucella* beetles into the center of the room (25-50 should be sufficient, more or less depending on the circumstances).
3. Have students brainstorm places where beetles might be found in the classroom (i.e. the window, the lights, sink, or the plants).

Activity 10. *Galerucella* RELEASE AND RETRIEVAL

4. Over a period of time—perhaps several days to a week—have students search for and record the locations where beetles are found. Attempt to identify the location of as many of the beetles as possible at any given time. (Perhaps assign several students to come in during lunch, recess, or study hall to look for beetles.) Students may want to sweep floors to find beetles. Continue all other normal daily activities in the room.
5. When searching for *Galerucella* beetles, if one is found on the host plant, purple loosestrife, it is considered to have reached its destination. Have students record how long it took for the beetle to find the loosestrife and the distance traveled from the original release site. Then remove the beetle from the experiment.
6. If any live *Galerucella* beetles are found elsewhere, have students record the location, but leave the beetles alone as they are still a part of the experiment.
7. If a dead *Galerucella* beetle is found, have students try to determine the cause of death (such as being stepped on, smashed in a book, caught in a spider web, etc.) and then record this information.
8. After a predetermined time has elapsed, have students use the information recorded to find out how many beetles made it to the "safe haven" of the purple loosestrife plant and how far they traveled in how long a time. Also, how many are either dead or missing and the suspected reasons for this. Have students graph their results.
9. Ask students to predict what the survival rates might be if more beetles were released, more purple loosestrife was made available, or if the loosestrife was closer to the release site.
10. Discuss variations that could be done to answer different questions about *Galerucella* beetle migration and survival during migration.

BACKGROUND INFORMATION

Survival of the *Galerucella* beetles depends on the amount of purple loosestrife that is available to them. The beetles actively search out the plant when they are released from captivity or emerge naturally from the soil in early spring and mid-summer. If the beetles do not find an adequate supply of purple loosestrife, they will not survive. In addition, the beetles are susceptible to all causes of mortality that any other insect may have to face, including predation, pesticides, and windshields.

In Europe and Asia, where the *Galerucella* beetles used as biological controls are native, the beetles continually migrate over long distances to new patches of purple

Activity 10. *Galerucella* RELEASE AND RETRIEVAL

(continued)

loosestrife. Old patches of the plant, having been attacked and weakened by as many as a hundred different kinds of insects, often disappear as the loosestrife is out competed by healthier plants of other species around them. Some *Galerucella* beetles also migrate from their wetland habitats in autumn to over winter in uplands. They return to the wetlands in the spring.

Thus, beetles reared and released here in Wisconsin can also be expected to find both new loosestrife patches and migrate in the fall and spring. In fact, biologists depend on the beetles to find new loosestrife plants since many hard to find patches of the plant will likely never receive beetles from DNR biological control cooperators.

It is important for us to understand the *Galerucella* beetles' local migratory behavior and determine what kinds of factors contribute to success or failure. Many beetles will die during migration, but if we know how many and why, we can better predict their effectiveness as biological controls. Perhaps something could even be done to make them more successful.

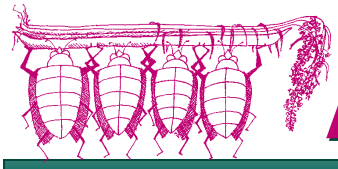
STUDENT ASSESSMENT

Students should be able to discuss the merits and short-comings of this activity and how their findings could or could not apply to what might occur in real life in an uncontrolled setting such as a wetland.

EXTENSIONS

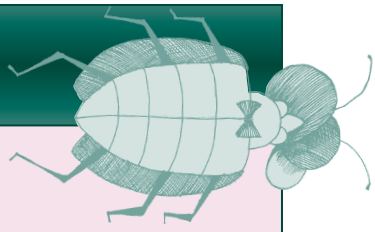
Conduct the experiment using the following variations:

- Change temperature and/or light conditions (**note:** these conditions vary due to room lighting, etc.).
- Change plant size and/or number.
- Use both new and old growth purple loosestrife plants.
- Move entire experiment to a larger room like a gymnasium or auditorium (with permission).
- Leave the classroom door open, and place plants down the hall at different distances from the release site (with permission).
- Devise a way this same experiment or parts of it could be done outside.
- Relate potential hazards in the classroom to hazards that may be encountered outdoors.
- If any beetles are missing, extend the experiment for a longer period of time to see if any of the missing beetles return.



ACTIVITY 11 GRADES 9-12

WETLANDS ON THE MEND



Objectives

➡ **Students will apply knowledge/skills gained in Activity 2, "Invasives Exposed!" to data collection with real plants.**

➡ **Students will explore the connection between biological control and wetland changes.**

➡ **Students will demonstrate that positive changes in the local environment can result from their efforts.**

Time Requirement

At least 3 class periods spread out over the springtime.

Wisconsin Model Environmental Education and Science Standards

Environmental Education: **A.8.2, A.8.4, A.8.5.** ***Science*****: C.8.2, C.12.3, F.12.7, F.12.8, F.8.8.**

B. WOODS

DESCRIPTION

Students generate and compare plant diversity indices from experimental and control mini-wetlands in pots to assess the potential effectiveness of biological control in real wetlands.

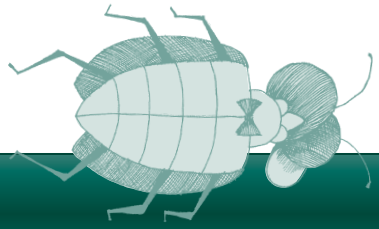
PROBLEM

Can the introduction of biological control insects to purple loosestrife infested wetlands increase wetland diversity?

Note: This activity is designed to accompany active biological control beetle rearing and is built around field placement and retrieval of potted loosestrife plants. Once set up the previous spring, the activity can be done entirely within the classroom the following spring. Materials and set-up are the same as for beetle rearing, except for netted control plants. See the Appendices for detailed beetle rearing instructions and equipment list.

MATERIALS

- ❑ Netting for cage for each pot.
- ❑ Shovel(s) or fork(s).
- ❑ 10-12 inch pots.
- ❑ Potting soil with fertilizer.
- ❑ Duct tape.
- ❑ Pool(s) for pots to sit in.
- ❑ Water source for potting and filling pool.
- ❑ Permanent markers, pens, and plastic flagging.
- ❑ Suspended line over pool.
- ❑ Sunny classroom or school yard space for pool.
- ❑ Purchased or field-collected *Galerucella* beetles, 10 per pot.
- ❑ Aspirator for moving or catching beetles.
- ❑ Copies of student Data Sheet (pages 42-43).
- ❑ Plant identification books.
- ❑ "Do Not Disturb" signs explaining that pots are for school experiment and will be collected.
- ❑ Beans and bags used in Activity 3.



Activity 11. WETLANDS ON THE MEND *(continued)*

PREPARATION
(for teacher or students; to be done annually)

1. Read and discuss the Background Information with students.
2. Sew (or have family or consumer education class sew) netting into cages.
3. Early in spring, dig and pot purple loosestrife rootstocks from a local wetland. (You may want a pair for each team of students, or one "experimental" pot for each team and only one to several "control" pots for the whole class to minimize set-up time. Twelve rootstocks is typical.)
4. Duct tape net cages onto the pots and suspend the cage tops.
5. Label pots "experimental" or "control" and number them. Treat them all the same from now on, except that experimental pots will get beetles and the controls will not.
6. When experimental plant(s) are about 2′ tall, put 10 *Galerucella* beetles onto each.
7. Before release, note the identity and count the number of all plants in each pot. (Count each stem at the ground as an individual plant.) Label each pot and record its number, the date, and all its plant data on a data sheet. (You may have to list only categories of plants to keep identification easy, such as loosestrife, grasses, broadleaf plants, etc., but try to identify as many groups or species as you can. Use made-up names, if necessary, to distinguish different kinds of plants. Tell how this was done for each pot under "Notes".)
8. In the summer, set all plants and pots with nets removed into a purple loosestrife infestation to release your beetles. Flag the plants so that each pot and its plants can be retrieved and evaluated the following spring.
9. Retrieve similar pots put out the previous year, with all contents.
10. Give each student group an experimental pot and either their own control pot or access to class control pot(s), along with the data sheets for these pots from the previous spring.
11. Give student teams a new data sheet for each pair of pots they are to survey.

B. WOODS

Purple loosestrife plants have extensive root stocks.

Activity 11. WETLANDS ON THE MEND

PROCEDURES

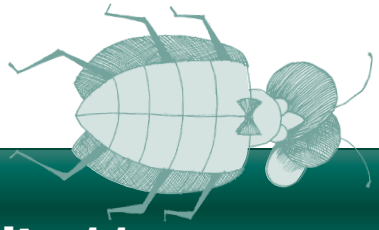
1. Have students keep the pots in a warm, sunny place and watered for up to several weeks to encourage all plants in the pot to grow.
2. Ask students to count the number of **new** loosestrife stems, if any, and, using notes from a pot's data sheet from the previous season, note the identity and number of any other **new** plant stems in the pot in the same manner as before (use same names; see preparation step 7.) Put the new season's data on a new data sheet along with the pot number(s) for easy comparison with the previous season.
3. Have students calculate diversity indices for both experimental and control pots for both years using the data from step one and the data from the previous year. Diversity indices are calculated as discussed in the Background Information and as shown at the bottom of the worksheet (page 42).
4. Ask students to compare/contrast indices for each pot and year and conclude whether plant diversity in any pot has changed and by how much.

PHOTOS: WISCONSIN WETLANDS ASSOCIATION

5. Have students answer the questions posed on the bottom of the worksheet.

BACKGROUND INFORMATION

You have perhaps already learned about biological diversity and at least one simple method for measuring it in a classroom simulation of organisms in a biological community. (See Activity 3, "Bean Biodiversity.") Remember that biological diversity is usually considered to be a measure of how many species there are, as well as their relative numbers or importance in their community. It is a very important concept because a diverse community is thought to be more stable and resistant to degradation, in spite of change around it, than a community with low diversity.



Activity 11. WETLANDS ON THE MEND *(continued)*

A model can be a great tool to use in understanding such natural processes, though data collected from real organisms is necessary to test the model. Perhaps you have already tried measuring plant diversity in a real wetland or other community as suggested in the extensions for Activity 3. If so, you should have been able to use the model's simple measure of plant diversity directly by recording the species identity of each plant as it was actually encountered along (under) a transect line instead of randomly drawing seeds out of a bag.

In this activity, you will survey pots of plants that can be considered to represent the larger wetlands from which they came and into which they were placed, treated the same, except subject to either intense experimental beetle predation or none at all (control). You will count how many species of plants are there and their numbers and calculate the pots' plant diversity. Then you should determine the change in diversity in all pots over time, comparing control(s) to experimental pots so you can draw conclusions about what is likely to happen to diversity in wetlands where the purple loosestrife is subjected to similar beetle feeding pressure.

There are a number of ways to calculate the "diversity" in a pot using its plant data. Use each of these three methods in analyzing your data from each pot:

1. Compare the total number of species in each pot as a measure of its diversity. More species are more diverse than fewer. This however does not consider how evenly the numbers of individuals are spread over all the species, an aspect of diversity we already know is important. For example, 10 plants of each 10 species has the same number of species as 91 of one species and 1 of each of another 9, yet the former is considered more diverse than the latter since interactions among the species are more complex.

2. Calculate "Species Richness" (SR), which equals the number of species/the square root of number of individuals. A large "SR" is more diverse than a small "SR," similar to the species number. This measure, however, adds relating species number to number of individuals (since most data are from only small samples of all the plants), giving a better idea of how diverse a set of plants is likely to be. A place where 100 individuals counted results in 10 species (SR = 1) is likely to be more diverse than when it takes 1000 individuals to find 10 species (SR = 0.1). This measure begins to address the "evenness" problem of #1 since fewer individuals should have to be sampled to get 10 species if there are more equal numbers of all the species. Still, in our example from #1 where the number of individuals counted is the same, both sets of plants have equal SRs (1).

Activity 11. WETLANDS ON THE MEND

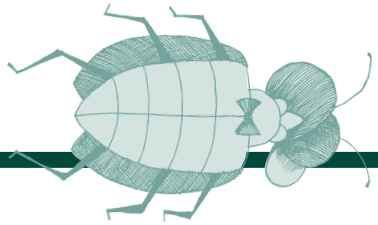
3. Finally, duplicate the Diversity Index (DI) as calculated in Activity 3 (DI = number of runs/number of individuals sampled) by filling a bag with seeds, based on the data from each pot. For example, if a pot has 3 loosestrife stems, its bag will have 3 of one type of seed, representing 3 loosestrife plants. A pot with 3 of each of 5 kinds of plants will have a bag with 3 of each of 5 kinds of seeds. Sample each bag's seeds randomly as in Activity 3 and calculate its DI. The more diverse the set of seeds, the closer to 1 the DI ought to be. Now, number of individuals, evenness, and chance all count. In our example from #1, 10 of each of 10 species should yield a DI much closer to 1 (say, 0.7) than 91 of one type and 1 of each of 9 others (perhaps 0.4). Note also that since chance can always cause any one sample of a bag to give an atypical DI, averaging several sample runs from each bag will give the most accurate results.

STUDENT ASSESSMENT

Have students write a lab report stating the problem, a hypothesis, experimental procedures, observations, analysis and conclusions. They should include calculations of the diversity measures discussed in the background information and a discussion of what effect biological control insects can have on plant diversity.

EXTENSIONS

Sample real wetlands, with and without the effects of beetles to see if their presence has any effect on plant diversity. Select either two wetlands that were nearly identical at first, one with biological control beetles (for at least two years) and one without, or one wetland with beetle infested and non-beetle infested ends. Try to keep all factors except presence or absence of beetles the same for the two areas sampled. (Ideally this would be done by sampling the same wetland before and after beetle release, however, this requires a study over two to three years or even longer.) Set up transects by tying a cord at least 2 meters up on two posts put into the ground at least 3 meters apart in each wetland area. Transects should ideally be much longer, perhaps up to 30 meters. Record the species identity of each plant as it is encountered along (under) the transect line. Calculate the Diversity Index for the wetlands as in Activity 3. If possible, do transects at several randomly chosen spots in each area, being sure to use the same number of counted individuals each time. Does each transect give the same index value? Why or why not? Average them for a good overall value. After comparing diversity measures in the two types of sites, what can you say about the effects of biological control beetles on the diversity of purple loosestrife and other plants? Apply any of the other calculations of diversity used in this activity to your data to further explore effects of biological control beetles on diversity.



Data Sheet: Plant species and their numbers in experimental and control purple loosestrife pots. (page 1 of 2)

Pot number: _____ **Date data taken:** _____

	Experimental Pot # _____ (beetles reared)	**Control Pot #** _____ (no beetles reared on these purple loosestrife plants)
	Plant Species and Number	**Plant Species and Number**
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		

Diversity Measures:

A. Number of species:_____

B. Number of individuals:_____

C. Species Richness = _____
(SR = $\sqrt{B}$)

D. Diversity Index = _____
(DI = # of runs/B)

Diversity Measures:

A. Number of species:_____

B. Number of individuals:_____

C. Species Richness = _____
(SR = $\sqrt{B}$)

D. Diversity Index = _____
(DI = # of runs/B)

Notes on how plant species or groups were identified:

Data Sheet: Plant species and their numbers in experimental and control purple loosestrife pots. (page 2 of 2)

Questions to answer:

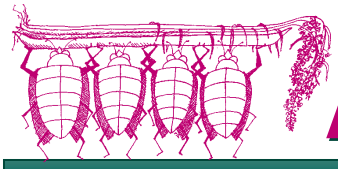
Which plant diversity measure seems best to you? Why?

Was any change in the diversity of the experimental and control pots the same?

In what way did plant diversity in the experimental pot change (if it did)?
Was it truly affected by the beetles? Why or why not?

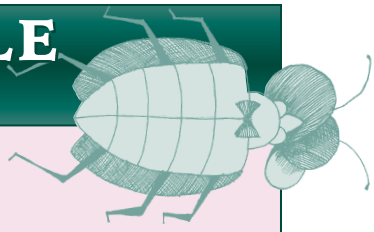
Based on your data and answers do you think that beetles reared at your school and released into local wetlands will have an effect on plant diversity there? Explain why.

Which type of wetland with loosestrife – one with biological control beetles or one without— do you think is likely to have the greatest animal diversity? Why?



ACTIVITY 12 GRADES 8-12

LIFE AFTER PURPLE LOOSESTRIFE



Objective

Students will design a wetland by choosing from bogs, marshes, swamps, and fens populated with native species.

Time Requirement

3 class periods.

Wisconsin Model Environmental Education and Science Standards

Environmental Education: **A.8.1, A.8.2, A.8.3, A.12.4, A.12.5, B.8.3, B.12.4.** ***Science*****: A.8.3, B.8.4, C.8.2, C.8.7, C.8.8, C.8.9,F.8.2, F.8.6, F.8.7, F.8.8, F.8.9, G.8.5, A.12.1, A.12.7, B.12.5, C.12.3, C.12.5, C.12.6, F.12.7, F.12.8, G.12.5, H.12.4, H.12.5, H.12.7.**

DESCRIPTION

Students custom-design their ideal wetland, after purple loosestrife has been controlled.

PROBLEM

What replaces the purple loosestrife?

MATERIALS

- ❑ Per student, 1 copy of the student handout (see "Preparation") or 1 copy of "Wetlands, Wonderlands" from the Wisconsin DNR.
- ❑ Art supplies.

PREPARATION

Obtain copies of the student handouts. This can be done by going to the Wisconsin DNR's website [**http://www.dnr.state.wi.us/org/water/fhp/wetlands/**] and selecting "Wet Is Wonderful," "Baby Boom or Bust?" and "A Spotter's Guide for Wetland Visitors," and printing out each page.

Activity 12. LIFE AFTER PURPLE LOOSESTRIFE

PROCEDURES

1. Give the following instructions to the students, having them work either individually or in small groups.
2. Select a wetland from "A Spotter's Guide for Wetland Visitors."
3. Choose enough plants to support the birds, mammals, reptiles, amphibians, and butterflies and other insects that will be incorporated into your restored wetland.
4. Make a diagram of your wetland, showing each species that you have selected.
5. Explain to the rest of the group, or to the class, the interactions among the species in your wetland.
6. Conduct a discussion of the students' choices of wetlands and compare the outcomes of each student's or group's choice.

BACKGROUND INFORMATION

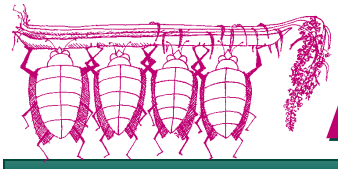
Removing purple loosestrife or other invasive species, native or not, is often the first step in re-building a quality wetland. (Although, sometimes even the basic physical water regime must be restored.) Where you go from there, however, depends on the desired end result. The instructor may read from the *Wetland Restoration Handbook for Wisconsin Landowners* published by the Wisconsin Wetlands Association in conjunction with the Wisconsin DNR. The book may be purchased from Wisconsin Wetlands Association for a $5 donation by calling (608) 250-9971 and requesting a copy or it can be downloaded, in its entirety, from the Wisconsin DNR website [**http://www.dnr.state.wi.us/org/water/fhp/wetlands/**]. A list of wetland resources can be found at **www.wiscwetlands.org/links/**.

STUDENT ASSESSMENT

Evaluate each student's or group's drawings, written explanations, and class presentations, noting how accurately they detail the interactions within a wetland and how clearly they communicate their ideas.

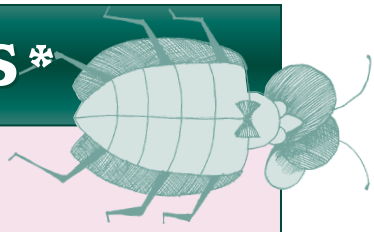
EXTENSION

A possible independent study relating to this activity is to have a student read *A Sand County Almanac* by Aldo Leopold.



ACTIVITY 13 GRADES 6-8

NATURAL ENEMIES*



Objective

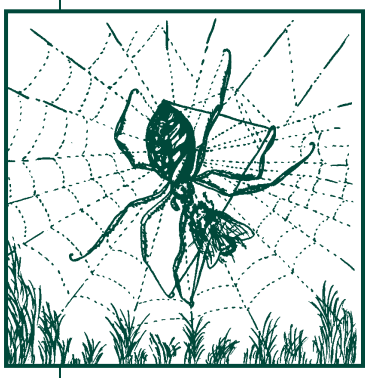
➡ **Students will create a "habitat" of prey and predators to study the relationships – who eats whom – in a food chain, in order to begin to understand what biological control is and how it works.**

Time Requirement

45 minutes.

Wisconsin Model Science Standards

Science: **B.8.8, F.8.8.**



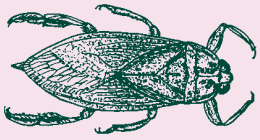
DESCRIPTION

Students play a version of dominoes, using names of organisms instead of dots. By matching up prey with its predator, students get a preview of the food chain and are introduced to the concept of biological control. By matching a pest with its predator, the pest species can be controlled or managed.

PROBLEM

What are some prey and predator relationships and how can predators be used to help control prey if the prey is a pest species?

MATERIALS



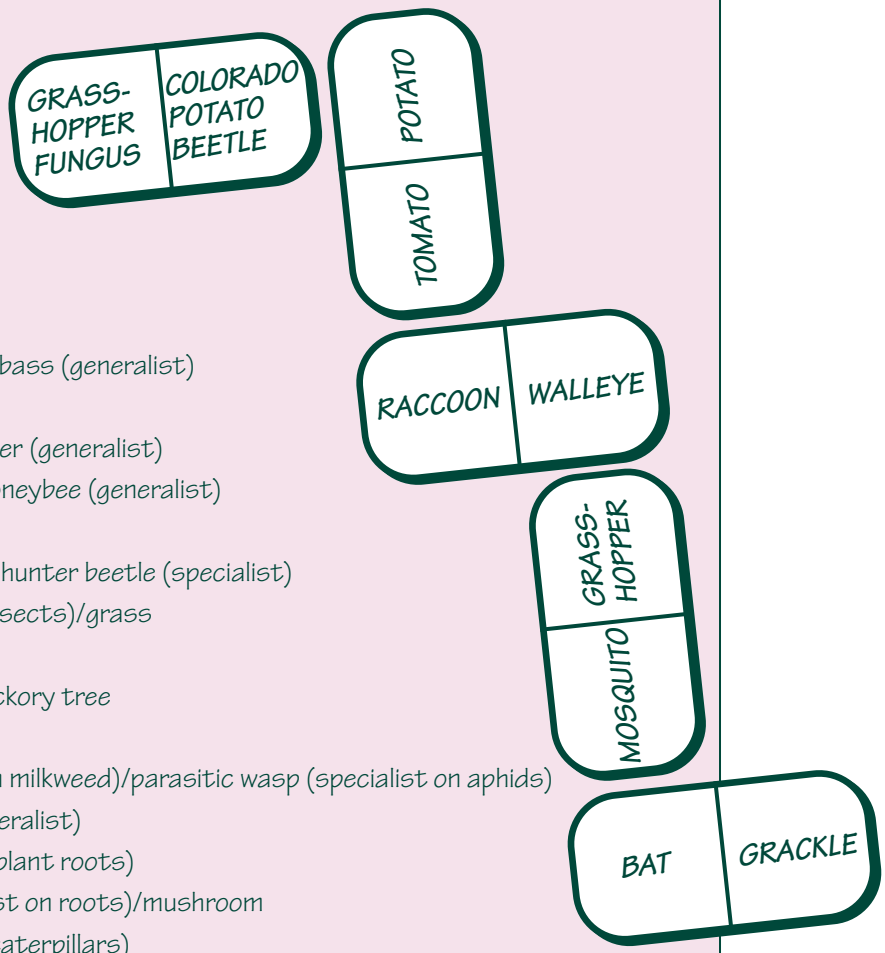
- ❑ A large, open area on the floor.
- ❑ Field guides.
- ❑ Per student, a copy of the list of card pairs (page 47).
- ❑ Per small group, one set of 34 4"x8" posterboard cards, each divided in half by a line and each end labeled in the pairs from the list on the next page.

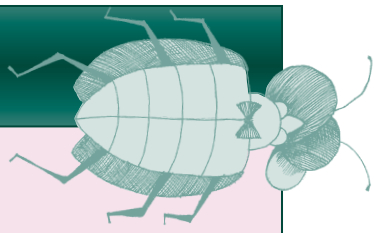
PROCEDURES

1. Introduce the activity with a set of dominos, and tell the students that they will use a modified version of these to learn the basics of biological control.
2. Project the card pair list onto a screen or wall and review the rules of the game, which are as follows:
   a. The cards begin in a stack on the floor, and each student starts with four cards.
   b. One student at a time picks a card and puts it into his/her card stack. The student then picks one card and positions it adjacent to the cards lined up on the floor so that the organism listed on one half of a card feeds upon or is fed upon by the organism on the card half that it is touching. Students may need to look up the type of food a particular organism might eat. Make sure students take into consideration the limitations or restrictions on each card.

Activity 13. NATURAL ENEMIES

- corn/soybean
- alfalfa/grass
- potato/cattail
- citrus tree/oak tree
- tomato/potato
- coyote (generalist)/elm tree
- apple tree/conifer aphid
- crayfish (generalist)/largemouth bass (generalist)
- algae/red fox (generalist)
- mosquito (generalist)/grasshopper (generalist)
- tomato hornworm (specialist)/honeybee (generalist)
- cow (generalist)/wildflower
- dragonfly (generalist)/caterpillar hunter beetle (specialist)
- lady beetle (generalist on small insects)/grass
- wheat/rose
- rose chafer beetle (specialist)/hickory tree
- milkweed/ant (generalist)
- monarch caterpillar (specialist on milkweed)/parasitic wasp (specialist on aphids)
- raccoon (generalist)/walleye (generalist)
- carrot/white grub (generalist on plant roots)
- underground root borer (generalist on roots)/mushroom
- deer/parasitic fly (generalist on caterpillars)
- wolf (generalist)/opossum (generalist)
- bat (generalist on insects)/grackle (generalist)
- loosestrife beetle (specialist)/muskrat (generalist on aquatic plants)
- soybean mosaic virus (specialist)/white-footed mouse (generalist)
- frog (generalist)/prickly pear moth (specialist)
- citrus virus (specialist)/cow tick (specialist)
- corn stalk borer (specialist)/cotton
- stalk borer parasite (specialist)/praying mantis (generalist)
- prickly pear cactus/hummingbird (generalist nectar feeder)
- bird louse (generalist on birds)/soybean pod borer (specialist)
- Colorado potato beetle (specialist)/grasshopper fungus (specialist)
- purple loosestrife/deerfly (generalist blood feeder)





c. As each student adds a card, he or she must explain why that play is justified. Encourage students to use terms such as "predator," "parasite," "pathogen" (disease), "host," "herbivore," "carnivore," and "natural enemy."

d. If a student does not have a card that can be placed, the student passes. (Teachers might come up with simple rewards for students who run out of cards earliest.)

3. Play the game. As students add cards, the community of organisms illustrated by the game becomes more complex. Continue play until as many cards as possible have been played or a student uses up all of his/her cards.

4. Select an organism that is in play from each group, and tell the class to assume that it has become a pest. Choose a likely example (e.g., tomato hornworm), and ask, which of all the rest of the organisms in play are potential enemies of this pest? Suggest to students that, even though the natural enemies may not be touching the pest in the game, they could be manipulated by humans for possible use as biological control agents.

5. Have students put the cards away and return to their desks for final discussion.

Discuss examples of introduced predators that have become problematic, such as the Asian Lady Beetle (see **www.uwex-edu/ces/wihort/gardenfacts/x1050.pdf**).

Discuss how the numbers of a given predator, parasite, or disease organism affect the numbers of the organism consumed. This relationship is the basis for the biological control of pests. As a class, develop a working definition of biological control, emphasizing that it involves the use of natural enemies by humans to help control or manage pests. Through biological control we increase the numbers and kinds of a pest's natural enemies so that the pest's numbers decrease.

BACKGROUND INFORMATION

Natural enemies fall into three basic categories: predators, parasitoids (parasites), and pathogens (disease). Predators are usually more general in their food habits and will feed on a wide variety of prey and are called generalists. Parasitoids, on the other hand, are considered specialists because they are likely to attack members of a certain group (e.g., moth caterpillars), a closely related group, or even a single species (e.g., gypsy moth caterpillar parasite). Pathogens may be generalists or specialists, depending upon the range of hosts that they attack.

Activity 13. NATURAL ENEMIES

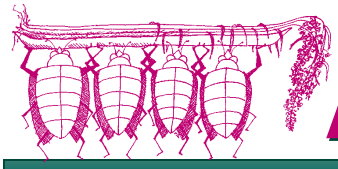
Energy and materials flow from prey to their natural enemies, which, in turn are preyed upon by other organisms. Thus, many organisms are connected to one another in a series, much like links in a chain. Biologists call these food chains. Often, such food chains interact through many organisms that are found in more than one chain, creating what is called a food web. A particular food web is often typical of a particular kind of habitat.

Sometimes, however, a predator is adapted to eat only one prey organism (though it may itself be eaten by many other predators.) Usually, there is a special relationship between these predators and their prey. These predators are ideal candidates for use in biological control. Can you see why? The *Galerucella* beetles we use to help control purple loosestrife are this kind of organism. Though they will sometimes "taste" other plants, as far as we know they can complete their life cycle only if they have purple loosestrife to eat. How does this make them ideal for our use even though they have been imported from another continent?

STUDENT ASSESSMENT

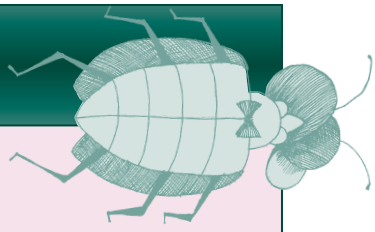
Each student takes a portion of the organisms from the above list and creates a food web, making it specific to a particular kind of ecosystem.

* Revised with permission from "Natural Enemies: They're in the Cards," in *Biodiversity, Wetlands, and Biological Control: Information and Activities for Young Scientists*, by Michael R. Jeffords and Susan L. Post, (Chicago: Illinois Natural History Survey) 2000.



ACTIVITY 14 GRADES 6-12

WISCONSIN WET 'N' WILD



Objective

➡ **Students will make value judgments about factors that affect the ecology of a wetland habitat.**

Time Requirement

50 minutes.

Wisconsin Model Environmental Education and Science Standards

Environmental Education: **B.8.3, B.8.5, B.8.6, B.8.8, B.8.10, B.8.15, C.8.3, D.8.7, B.12.2, B.12.3, B.12.4, B.12.6, B.12.7, B.12.11, C.12.1, D.12.4.** ***Science*****: B.8.6, C.8.11, F.8.9, F.8.10, A.12.1, A.12.2, A.12.4, F.12.7, F.12.8, G.12.5, H.12.6, H.12.7.**

DESCRIPTION

This game acquaints students with the biological complexities of a wetland habitat and reviews factors destructive to or sustaining of Midwestern wetlands and their associated landscapes. Students should enjoy the game, but they should also perceive the biological and social relevance of the information presented.

PROBLEM

What are some of the diverse factors that affect the ecology of a wetland habitat?

MATERIALS

Per student group:

- ❑ A copy of "Rules of the Game" handout (page 52).
- ❑ A game board.
- ❑ A set of fact cards (pages 53-68).
- ❑ A die and a game token for each player.

PREPARATION

Construct the game boards. The template for a game board is a typical game board that has a *start* space and a series of 20-30 spaces that lead to the *finish* space. You could create game boards that fit onto a table or use a series of squares on the ground and have the students walk across the board instead of moving tokens. Some of the squares must be shaded.

Mount copies of Wetland Facts on poster board or cardboard and cut out sets of game cards, keeping only one statement on a card.

U.S. FISH AND WILDLIFE SERVICE

WISCONSIN WETLANDS ASSOCIATION

Unfortunately, many of Wisconsin's wetlands have been harmed by human activity over the past 100-150 years. Today regulations control the draining and filling of wetlands.

Activity 14. WISCONSIN WET 'N' WILD

PROCEDURES

1. Divide the class into groups of four students. Distribute the materials so that each group has a game board, a copy of the rules, a die, tokens (if they are used), and a set of fact cards.
2. Ask students to read the rules before beginning play, or explain the rules to the class as a whole. The latter may be the preferred strategy because you can emphasize the concepts that students should think about and discuss during the game.
3. Monitor the play as lively discussions are likely to develop. If discussions take enough time that a group may not even finish the game, then establish a maximum amount of time that students may take to reach a decision. Assist any group that has difficulty understanding the information presented in the Wetland Facts cards or reaching fair and reasonable decisions. Various interpretations of the same statement are possible. For example, any statement may be judged positive by one group and neutral by another. One interpretation is not necessarily more correct than the other, but the justification for the choice should be plausible.

Each student orally responds to which fact card was most impressive or enlightening to him/her.

BACKGROUND INFORMATION

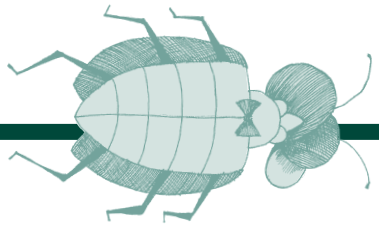
At this point in their study of wetlands, students should be aware of the need to preserve our remaining wetlands and the challenge of recovering others. As a general review and as an introduction to this activity, generate with the class a list at the chalkboard of the values of wetlands. Give hints to help students make this list as long as possible. Include everything from natural fish nurseries to flood control to bird habitat. Explain that students will now play a game that will add to their understanding of the value of wetlands.

STUDENT ASSESSMENT

Each student selects one statement from the cards and writes a paragraph justifying why that statement is beneficial or detrimental to wetlands and their associated landscapes. Check the choices before students begin writing to ensure that no one has selected a neutral statement unless he or she has an idea for a valid justification.

EXTENSION

Have students search newspapers, magazines, and other current materials for articles on wetlands and wetland habitats. Good sources are natural history magazines such as *Audubon*, *National Wildlife,* and *National Geographic*. Have students read the articles and pull out pertinent facts about wetlands, such as those included in this lesson. Have them create their own set of cards and replay the game. Another activity is to create a bulletin board display of these facts that have been lumped into the three categories used above.



Wisconsin Wet 'N' Wild

Rules of the Game

1. One student shuffles the game cards and places them face down in the center of the playing board.

2. Each player chooses a token (if they are used) and places it on *Start*.

3. Each player, in turn, rolls the die; the player with the highest number begins the game by rolling the die again and moving forward the indicated number of spaces.

4. If the player lands on an unshaded square, the turn passes to the next player. If the player lands on a shaded square, the player draws a game card from the top of the pack and reads aloud the statement on it. The other three players then decide if the statement is positive (beneficial), negative (destructive), or simply neutral with regard to wetlands and their associated landscapes. The player who landed on the square may express an opinion, but the ultimate judges are the other players.
   - If the statement is considered negative, the player moves back one square.
   - If the statement is considered positive, the player moves forward one square.
   - If the statement is considered neutral, the player remains on the same space.

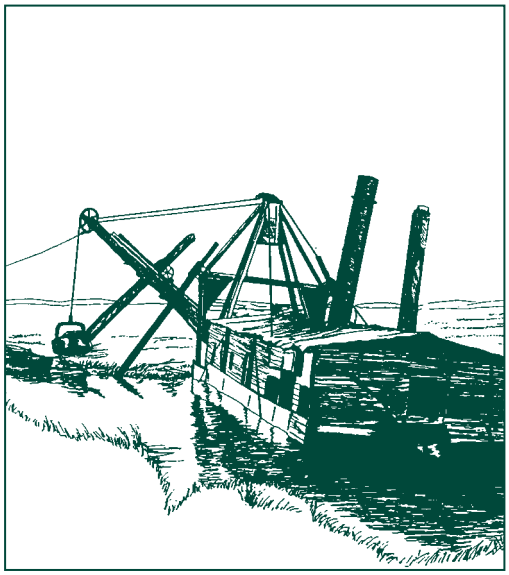
   Then the player's turn ends, and the next player takes a turn.

5. If a player's token lands on an occupied square, the player moves it back to the nearest unoccupied square.

6. Play proceeds until each player reaches *Finish*. Finishing first may in itself be enough reward, but you can also grant the winner the power to be the sole judge of the wetland _____ for the remainder of the game. The other players, of course, continue to express their points of view.

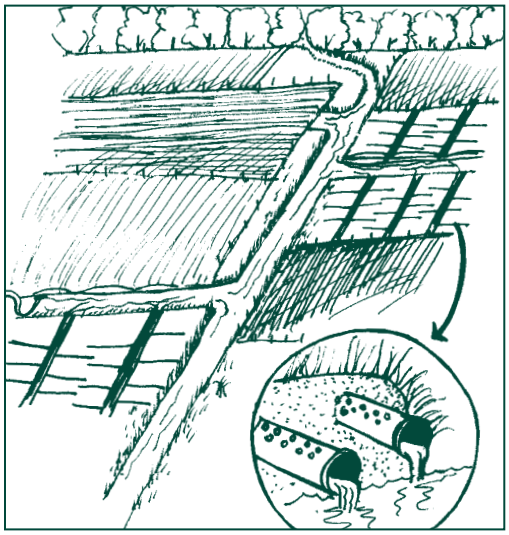
Wisconsin Wet 'N' Wild Game Card

Sixty acres of wetlands are destroyed each hour in the United States.



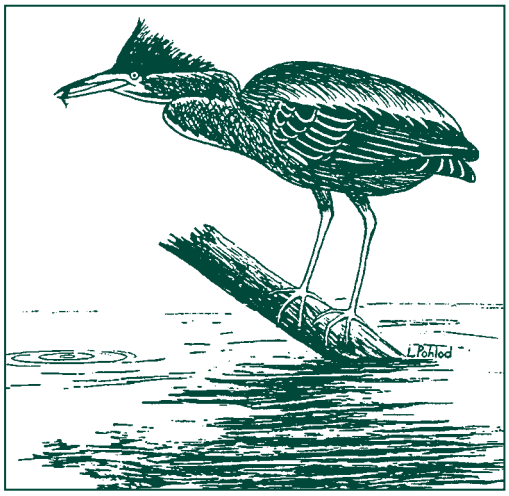
Wisconsin Wet 'N' Wild Game Card

The water table in a marsh is permanently lowered due to the drainage of adjacent farmland.



Wisconsin Wet 'N' Wild Game Card

When water levels drop, fish and other animals are concentrated in small pools. Wetland birds like herons, egrets, and eagles have a feast.

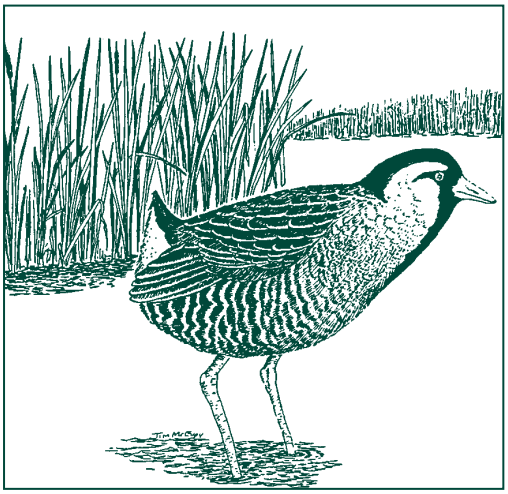


Wisconsin Wet 'N' Wild Game Card

A family of beavers dams a small stream to create a large, shallow wet area. Soon cattails, bulrushes, and arrowhead plants colonize the site.

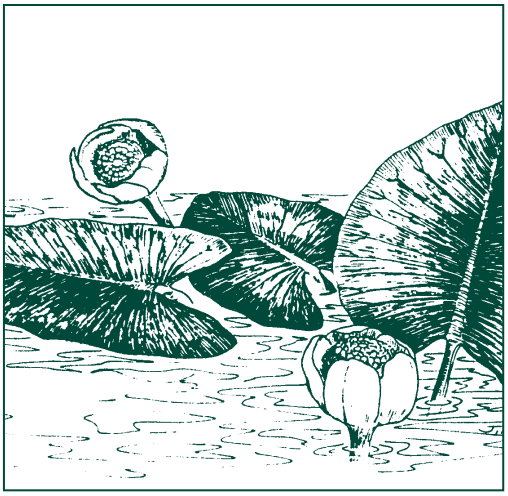
Wisconsin Wet 'N' Wild Game Card

During dry weather, mudflats are exposed and moist plants grow and produce seeds that are eaten by waterfowl and other birds.



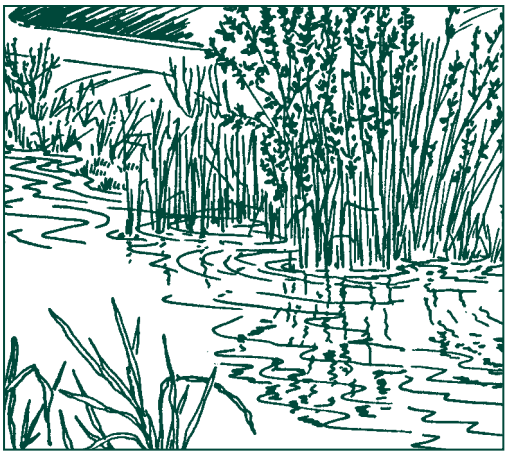
Wisconsin Wet 'N' Wild Game Card

The leaves of floating plants, like water lillies, provide a home for many small animals on their upper and lower surfaces.



Wisconsin Wet 'N' Wild Game Card

During the late summer, when the water level drops, marsh soils are exposed to oxygen, thereby speeding the process of plant decay and the recycling of nutrients.

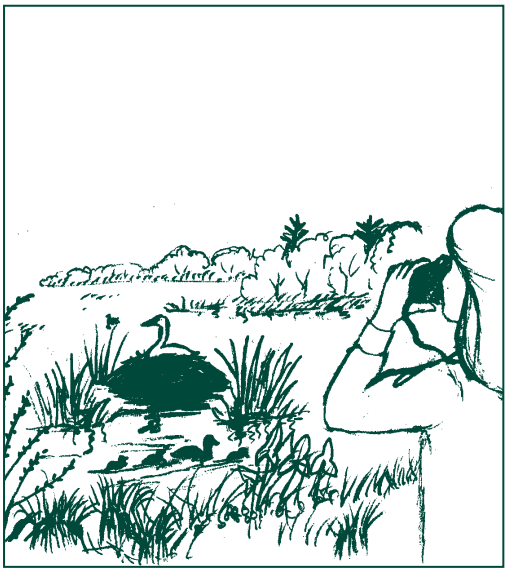


Wisconsin Wet 'N' Wild Game Card

Along the wetland margin, abundant cattails, rushes, and sedges provide an ideal home for the endangered rice rat.

Wisconsin Wet 'N' Wild Game Card

Migrating birds use wetlands on a seasonal basis to rest, feed, and raise their young.

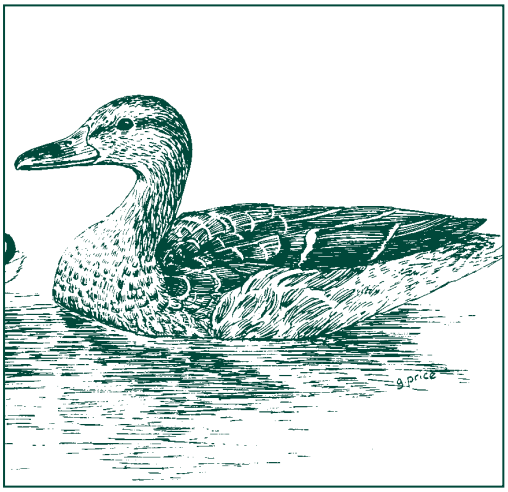


Wisconsin Wet 'N' Wild Game Card

Many kinds of invertebrates – mollusks, sponges, flatworms, crustacea, and insects – are important parts of food chains and transfer energy to other organisms.

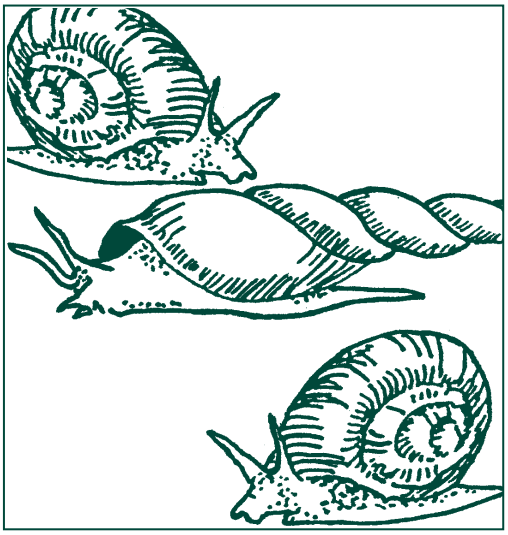
Wisconsin Wet 'N' Wild Game Card

The different water depths in a marsh allow both dabbling (mallard) and diving (canvasback) ducks to forage for food.



Wisconsin Wet 'N' Wild Game Card

The presence of mussels and snails indicates that water is relatively clean and free of pollution.



Wisconsin Wet 'N' Wild Game Card

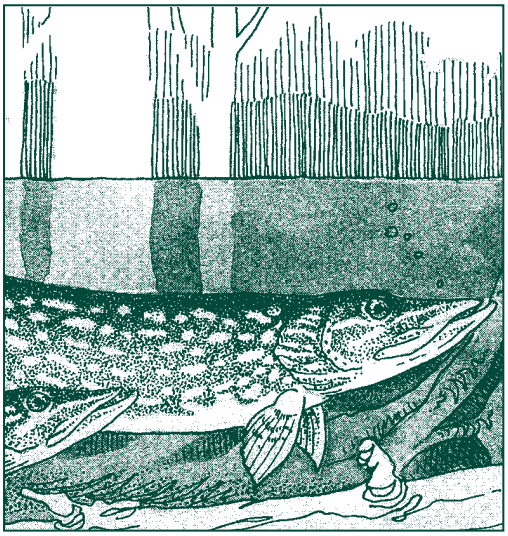
Frogs, toads, and salamanders find wetlands ideal feeding and breeding grounds each spring and early summer.

Wisconsin Wet 'N' Wild Game Card

More kinds of plants live in the moist soil around wetland edges than live in the open water.

Wisconsin Wet 'N' Wild Game Card

Fishes that inhabit marshes must be able to tolerate water and relatively warm temperatures.



Wisconsin Wet 'N' Wild Game Card

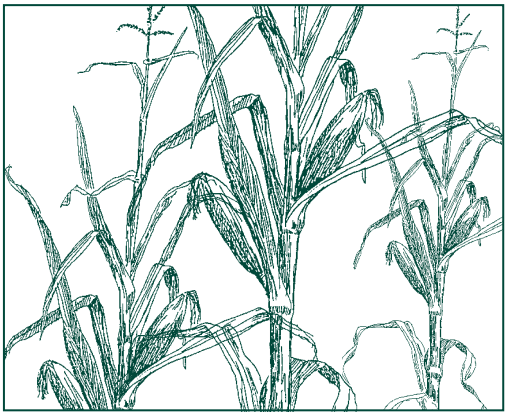
A large quantity of living things (biomass) is produced in a wetland; thus wetlands are said to be highly productive.

Wisconsin Wet 'N' Wild Game Card

The soils and water in a bog are very acidic and allow only a few species of plants to grow.

Wisconsin Wet 'N' Wild Game Card

A wetland next to a large river is leveled, drained, and planted with corn. During the rainy season, water that originally remained trapped in the wetland now flows downstream and causes flooding.

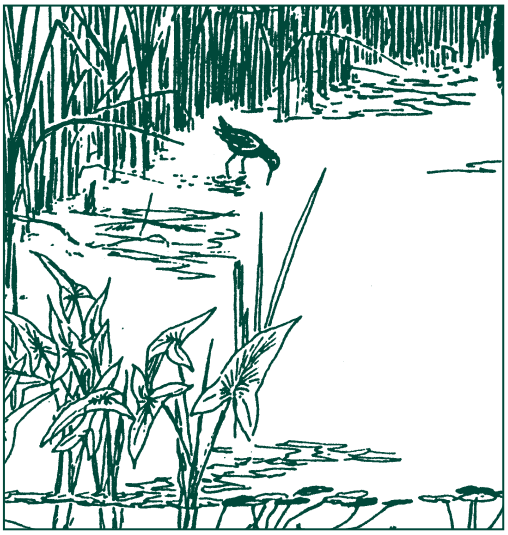


Wisconsin Wet 'N' Wild Game Card

Wetlands provide habitat for an incredible number of plants and animals.

Wisconsin Wet 'N' Wild Game Card

Peat and muck wetland soils attract polluting chemicals and allow them to be broken down by microorganisms.

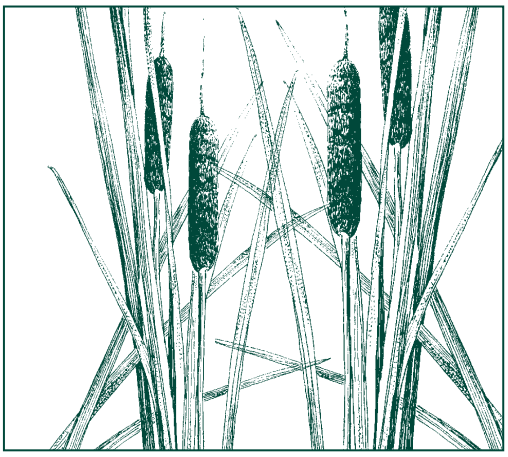


Wisconsin Wet 'N' Wild Game Card

Cattails and bulrushes take up a large percentage of polluting nitrates that are washed off from nearby farm fields and convert these chemical substances to plant tissue.

Wisconsin Wet 'N' Wild Game Card

Extra nitrogen (nitrates) from farm fields allows a single species of plant, cattails, to out compete its neighbors, thereby reducing the diversity of the marsh.



Wisconsin Wet 'N' Wild Game Card

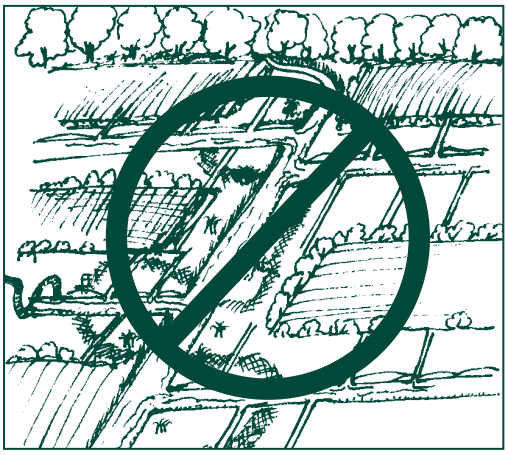
Soil eroded from nearby fields (sediment) is trapped by wetland plants and settles to the bottom before it can enter a river.

Wisconsin Wet 'N' Wild Game Card

Wetlands act as sponges and store water from wetter times. During a drought, this water is slowly released into nearby streams.

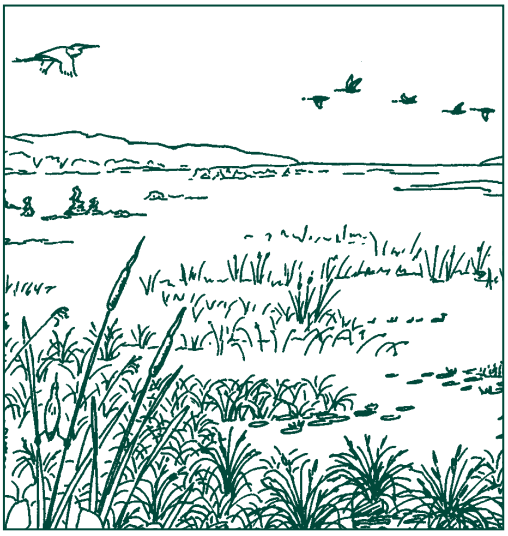
Wisconsin Wet 'N' Wild Game Card

For wetlands to serve their biological functions, they must not be levied, drained, channelized and straightened, or stripped of their native vegetation.



Wisconsin Wet 'N' Wild Game Card

Only 103.3 million acres of the original 221 million acres of wetlands in the United States remain.



Wisconsin Wet 'N' Wild Game Card

More plant material is produced in a marsh than in a cornfield. Wetland plants can produce 25,000 pounds of dry plant matter per acre; an acre of corn yields about 12,500 pounds.

Wisconsin Wet 'N' Wild Game Card

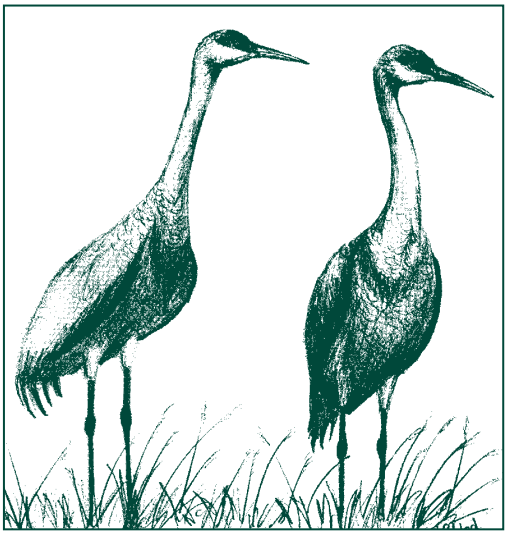
Wisconsin has over 40,000 acres with purple loosestrife, and state law bans the sale, distribution, or cultivation of the plant. There is a $100 fine per violation.

Wisconsin Wet 'N' Wild Game Card

One-third of all threatened and endangered plants and animals in the United States rely on wetlands for their homes.

Wisconsin Wet 'N' Wild Game Card

Wildlife use wetlands as corridors through which they move in search of food and shelter.



Wisconsin Wet 'N' Wild Game Card

Wetlands are beautiful.

Wisconsin Wet 'N' Wild Game Card

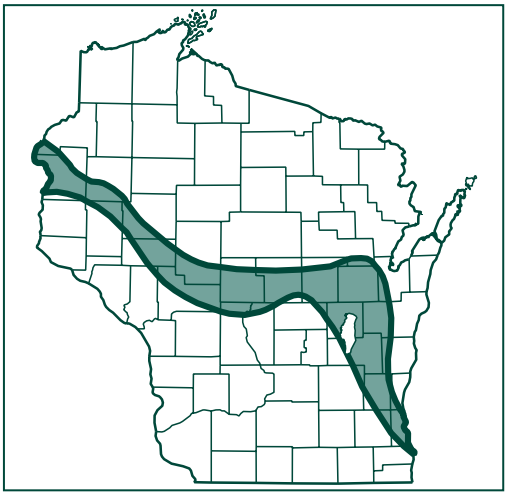
Wetlands have a profound ability to improve water quality. They help keep water supplies clean by trapping sediment and filtering out contaminants.

Wisconsin Wet 'N' Wild Game Card

Of the original 10 million acres of wetland in Wisconsin at the time of European settlement, today only about half remains.

Wisconsin Wet 'N' Wild Game Card

Wetland vegetation often differs from northeastern to southwestern Wisconsin, with a mixing of the two in the "tension zone."



Wisconsin Wet 'N' Wild Game Card

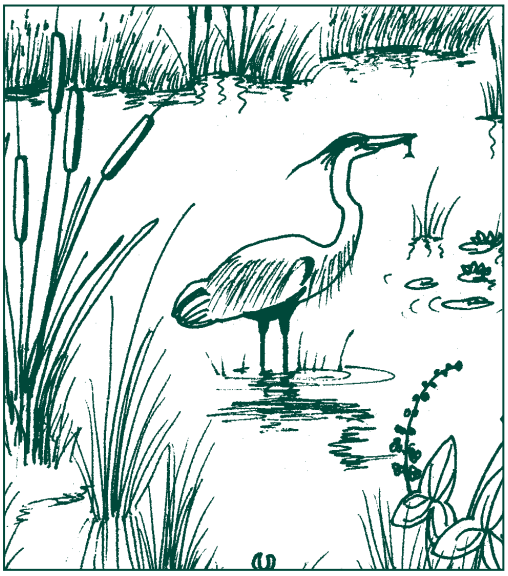
Prairie wetlands are the most productive of all temperate ecosystems. Their lush growth is used by wildlife for food, cover, and breeding.

Wisconsin Wet 'N' Wild Game Card

Wetlands reduce the turbidity of water. As sediment-laden water enters a wetland, is loses velocity, and the suspended solids settle to the bottom.

Wisconsin Wet 'N' Wild Game Card

Ten states in the United States have lost more than 70 percent of their wetlands.



Wisconsin Wet 'N' Wild Game Card

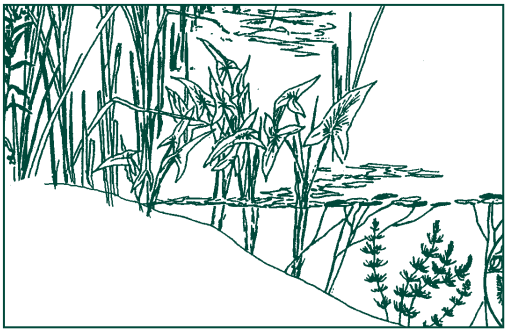
Wetland vegetation has a filtering effect. Solids are knocked out of the water as they attach to the stems and roots of aquatic plants.

Wisconsin Wet 'N' Wild Game Card

Wetlands reduce flood peaks by storing water.

Wisconsin Wet 'N' Wild Game Card

Wetland plants improve water chemistry. Nitrogen, phosphorus, and carbon provide the basic elements for the growth of plant cells. As these three elements are removed from water and put into plant production, the water becomes clearer.

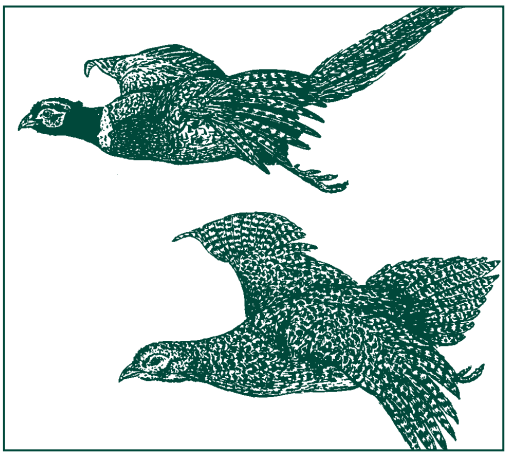


Wisconsin Wet 'N' Wild Game Card

More than 117 million acres of wetlands have been lost in the lower 48 states since colonial times – over half the estimated original total wetland acreage.

Wisconsin Wet 'N' Wild Game Card

In harsh winters with heavy snow, the dense tangle of marsh vegetation provides cover for pheasants – sometime the only cover they can find.

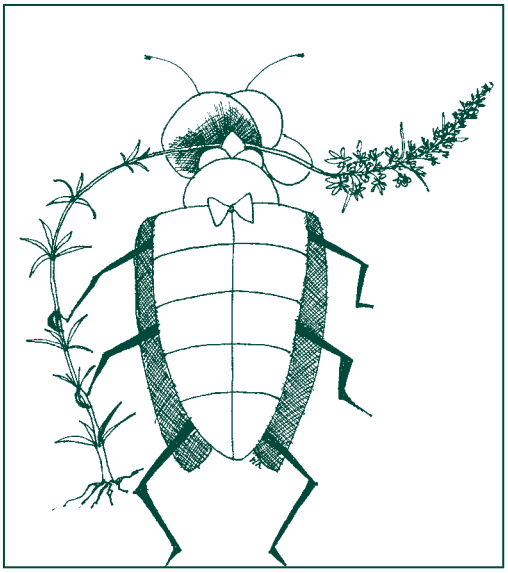


Wisconsin Wet 'N' Wild Game Card

In Wisconsin and elsewhere, nitrates are a serious source of ground water contamination and a threat to the quality of drinking water. Because nitrates are very soluble, they leach quickly through the soil into shallow aquifers. If nitrates enter a wetland, however, they experience a chemical transformation. The microbes present in wetland sediments convert the potentially harmful nitrates into nitrogen gas, which is harmless.

Wisconsin Wet 'N' Wild Game Card

Eurasian beetles are released in Wisconsin wetlands to help control purple loosestrife.



Wisconsin Wet 'N' Wild Game Card

A study conducted in Eagle Lake Marsh, Iowa found that 86 percent of the nitrate level of the lake had been removed by the time the water made its way to the outlet of the marsh.

Wisconsin Wet 'N' Wild Game Card

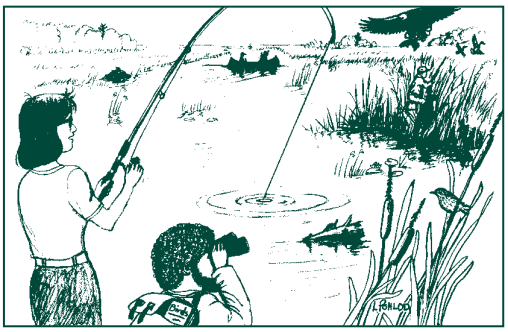
Some people maintain that the highest value to be placed on wetlands is their potential development as real estate and crop-producing acreage.

Wisconsin Wet 'N' Wild Game Card

Drained and tiled wetlands made some of the richest farmland in the Midwest.

Wisconsin Wet 'N' Wild Game Card

Some people maintain that the highest value to be placed on wetlands is their ability to improve the quality of water and to provide habitat for a remarkable diversity of plants and wildlife. Others think that their recreational value is most important.

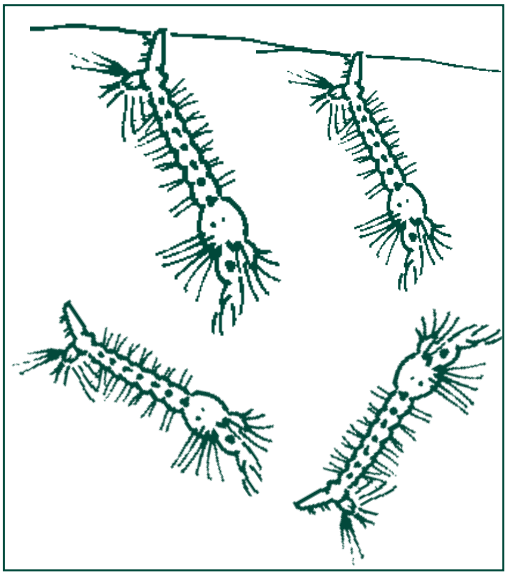


Wisconsin Wet 'N' Wild Game Card

Purple loosestrife colonizes a wetland.

Wisconsin Wet 'N' Wild Game Card

Mosquito larvae are an important food source for young fish.



Wisconsin Wet 'N' Wild Game Card

Purple loosestrife is beautiful.

Wisconsin Wet 'N' Wild Game Card

A wetland becomes dry during a drought and a land developer builds an apartment building on it.

Wisconsin Wet 'N' Wild Game Card

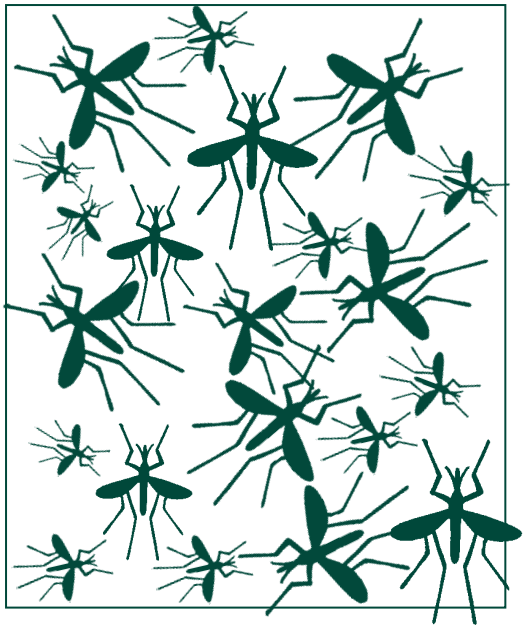
Wetlands attract duck hunters.

Wisconsin Wet 'N' Wild Game Card

Previous generations have found wetlands useful as places to dump their trash.

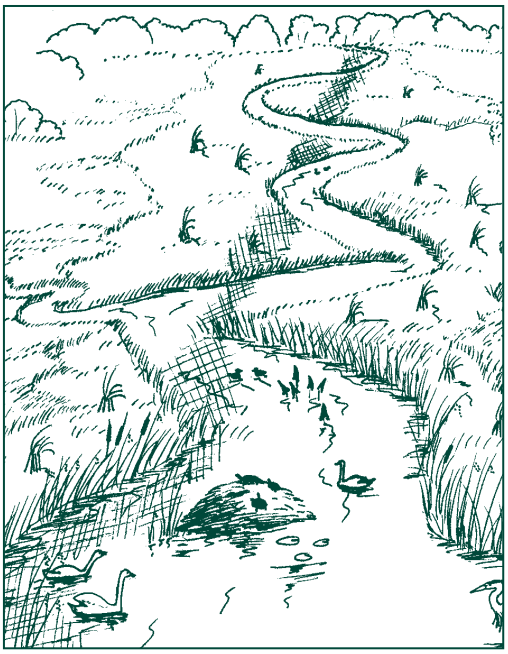
Wisconsin Wet 'N' Wild Game Card

Mosquitoes reproduce in large numbers in wetlands.



Wisconsin Wet 'N' Wild Game Card

Wetlands can be restored.



Wisconsin Wet 'N' Wild Game Card

Reintroduction of a native plant such as wild rice is an important component of wetland restoration in Wisconsin.

Wisconsin Wet 'N' Wild Game Card

STUDENT CARD

Wisconsin Wet 'N' Wild Game Card

STUDENT CARD

Wisconsin Wet 'N' Wild Game Card

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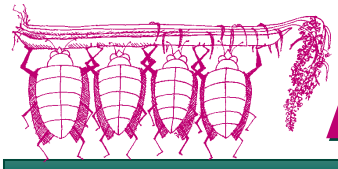
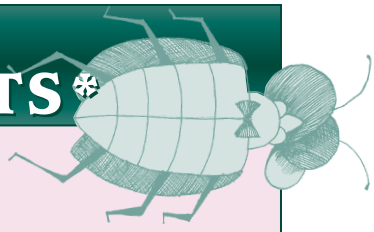


ACTIVITY 15 GRADES 6-12

WISCONSIN'S WETLAND HABITATS



Objective

➡ **Students will classify Wisconsin wetlands based on their characteristics.**

Time Requirement

45 minutes.

Wisconsin Model Environmental Education Standards

Environmental Education: **B.8.6.**

WISCONSIN WETLANDS ASSOCIATION

DESCRIPTION

This activity uses a flow chart and dichotomous key to introduce and identify the common types of Wisconsin wetlands.

PROBLEM

What are the differences between Wisconsin's wetlands?

MATERIALS

- ❑ Copies of "Wisconsin Wetland Habitats" worksheet (page 71), "Wisconsin Wetlands Dichotomous Key" (page 73), and "Wisconsin Wetlands Identification Chart (pages 74-75).
- ❑ Copies of "Habitat Cards" (pages 76-78) on stiff paperboard.
- ❑ Paper and pencils.

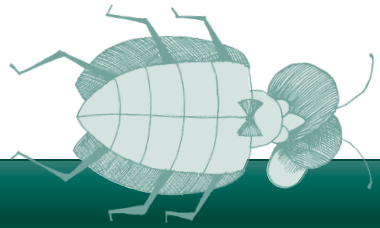
PROCEDURES

1. Discuss with the students the activity's background information.
2. With the students, define the word "habitat."
3. Explain to the students that they will be using a flow chart (identification chart) to identify twelve wetland types by their characteristics and the habitats they provide. Identify the first card together as a class.
4. Have the students, working individually or in pairs, identify the remaining habitats and write their answers on the sheet provided.

BACKGROUND INFORMATION

A habitat is the place where an animal finds food, water, shelter, and space in a particular arrangement. Wetlands offer a wide variety of habitat types for many species of wildlife.

An area does not always have to be wet to be considered a wetland. Many wetlands are covered by water only during the rainy spring season. Others are regularly or infrequently flooded, while some may be covered by water most or all of the time. Sometimes on a visit to a wetland, it is difficult to tell just how wet it is. In these cases, the types of plants found there are often the best indicators. In fact, many wetlands are named by the plant species found most commonly in them.



Activity 15. WISCONSIN'S WETLAND HABITATS

(continued)

Wetlands can receive their water from springs, streams, rivers, ponds or lakes, or rainwater or snowmelt. Differences in wetness, as well as slope, elevation, and climate cause differing plant communities to develop. Wetlands are classified, in part, by the water, frequency and degree of inundation, and types of vegetation most prevalent there.

STUDENT ASSESSMENT

- Students should be able to name different types of wetlands and/or identify wetlands using the identification materials provided.
- Students should be able to identify qualities that might distinguish one type of wetland from another.

EXTENSIONS

Students can draw a web showing interactions between an imaginary plant and its ecosystem. They can predict the population growth of their imaginary plant relative to other organisms in the web.

Wisconsin has a variety of wetland types.

* Adapted from *WOW: Wetland Habitats.* Information on Wisconsin wetlands was taken from the *Wetland Restoration Handbook for Wisconsin Landowners.*

Wisconsin Wetland Habitats

Name(s) _____

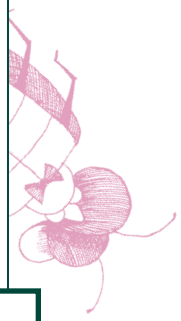
_____

The fifteen types of wetlands in Wisconsin are:

alder thicket	deep marsh	shallow marsh
calcareous fen	floodplain forest	shallow, open water
cedar swamp	hardwood swamp	shrub carr
coniferous bog	open bog	wet meadow
coniferous swamp	sedge meadow	wet prairie

Using the Identification Chart and/or Dichotomous Key provided, identify the Habitat Cards. Write your answers in the lines below.

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____
12. _____



Terms Used in the Dichotomous Key and Flow Chart:

acidic—having a pH less than 7.0

alkaline—having a pH greater than 7.0

coniferous—trees such as pines, spruces, firs, and yews

emergent vegetation—plants that have their roots in the water but also grow above the surface of the water; examples are cattails and wild rice

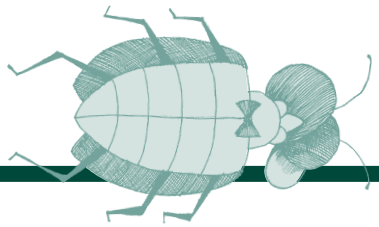
floating vegetation—plants that may or may not have their roots in the soil but float on the water's surface; examples are lilies and duckweed

forb—a flowering plant

hardwood—trees such as oak, cherry, hickory, etc.

submergent vegetation—plants that have their roots in the water but do not extend above the surface of the water

woody vegetation—generally, shrubs and trees; plants with a hard, woody stem



Wisconsin Wetland Habitats Answer Key

Name(s) _____

_____

The fifteen types of wetlands in Wisconsin are:

alder thicket	deep marsh	shallow marsh
calcareous fen	floodplain forest	shallow, open water
cedar swamp	hardwood swamp	shrub carr
coniferous bog	open bog	wet meadow
coniferous swamp	sedge meadow	wet prairie

Using the Identification Chart and/or Dichotomous Key provided, identify the Habitat Cards. Write your answers in the lines below.

1. deep marsh
2. alder thicket
3. wet meadow
4. sedge meadow
5. coniferous bog
6. shallow marsh
7. hardwood swamp
8. wet prairie
9. coniferous swamp
10. calcareous fen
11. shrub carr
12. flood plain forest

Wisconsin Wetlands Dichotomous Key

1a. Land is always covered with water…2
1b. Land is sometimes NOT covered with water…3

2a. Less than 6 feet deep standing water; mostly submergent vegetation …**shallow, open water wetland**
2b. Greater than 6 inches of standing water; submergent & emergent vegetation …**deep marsh**

3a. Has woody vegetation…4
3b. Does not have woody vegetation…10

4a. Shrubs and woody vegetation less than 20 feet in height…5
4b. Shrubs and woody vegetation greater than 20 feet in height…6

5a. Dominated by alder…**alder thicket**
5b. Dominated by red osier dogwood and willows…**shrub carr**

6a. Saturated soils; usually not standing water…7
6b. Seasonally flooded; very dry late in the growing season…**flood plain forest**

7a. Includes tamarack…8
7b. No tamarack…**hardwood swamp**

8a. Saturated peat soil with slightly acidic to slightly alkaline pH…9
8b. Dominated by sphagnum moss and representative bog plants; very acidic soil; contains tamarack and black spruce…**coniferous bog**

9a. Dominated by tamarack and northern white cedar…**cedar swamp**
9b. Dominated by tamarack and black spruce…**coniferous swamp**

10a. Saturated soils with little or no standing water…11
10b. Standing water during much of the year (most years); water level less than 6 inches; generally has only emergent plants…**shallow marsh**

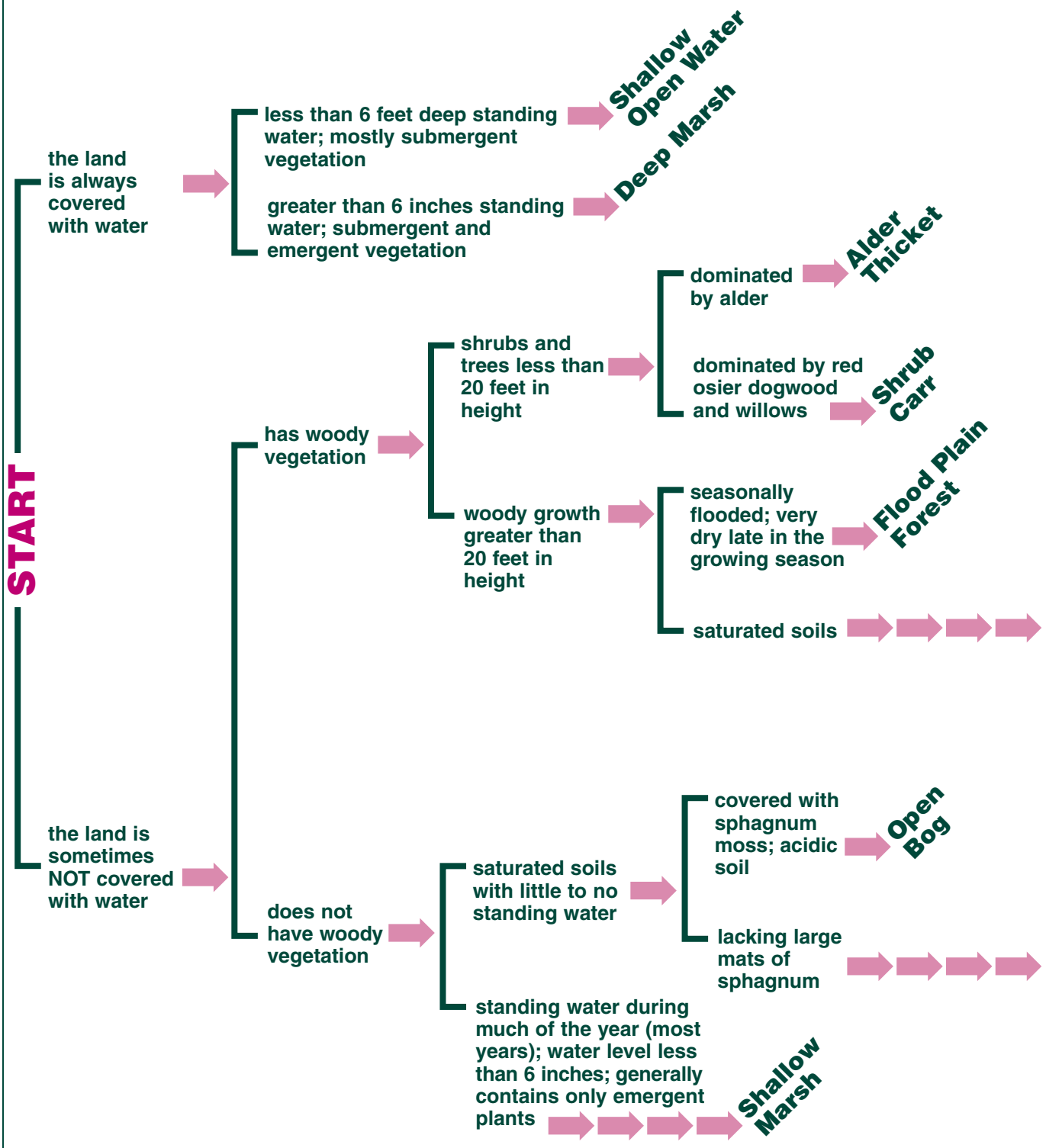
11a. Lacking large mats of sphagnum…12
11b. Covered with sphagnum moss; acidic soil…**open bog**

12a. Soil is not alkaline…13
12b. Soil is alkaline; rare plant species such as ladyslipper orchid and white fringed gentian…**calcareous fen**

13a. Dominated by grasses and forbs…14
13b. Dominated by sedges…**sedge meadow**

14a. More wet; dominated by grasses with some forbs such as goldenrod or aster …**wet meadow**
14b. More dry; dominated by forbs with some grasses such as prairie cord grass…**wet prairie**

Wisconsin Wetlands Identification Chart



- no tamarack → **Hardwood Swamp**
- includes tamarack
  - saturated peat soil; slightly acidic to slightly alkaline pH
    - dominated by tamarack and northern white cedar → **Cedar Swamp**
    - dominated by tamarack and black spruce → **Coniferous Swamp**
  - dominated by sphagnum moss and representative bog plants; very acidic soil; contains tamarack and black spruce → **Coniferous Bog**
- soil is alkaline; rare plant species such as ladyslipper orchid and white-fringed gentian
  - dominated by sedges → **Calcareous Fen**
- soil is not alkaline
  - dominated by grasses or forbs
    - more wet; dominated by grasses with some forbs such as goldenrod and aster → **Wet Meadow**
    - more dry; dominated by forbs with some grasses such as prairie cord grass → **Wet Prairie**

Wisconsin Wetland Habitat Card

1 This wetland is always covered with more than six inches of standing water. You will find cattails and water lilies growing here. You will also see plants growing from the wetland bottom that don't emerge from the water. The water level varies from year to year.

Wisconsin Wetland Habitat Card

2 Along the spongy, moist stream bank grows multi-stemmed, speckled alder trees. The dense, overhanging branches of these six to twelve foot tall trees help keep the stream cool. This habitat usually has standing water only in the early spring.

Wisconsin Wetland Habitat Card

3 This field feels soggy as you walk over it but has standing water during part of the year. The soil has a pH of about 6.5. The vegetation consists of some sedges but mostly of grasses. There are also some flowering plants.

Wisconsin Wetland Habitat Card

4 Depressions in a field may fill with rain and ground water and stay wet for several days or weeks. Landowners often mow or plow around these spots to avoid getting tractor wheels stuck in the soft ground. On spring evenings, these puddles seem alive with the high-pitched calls of spring peepers (tiny frogs) looking for mates among the rushes and sedges that grow here. In the heat of the summer, these places usually dry up.

Wisconsin Wetland Habitat Card

5 In this low-lying area, the land is usually spongy and moist but generally does not have standing water. The tamaracks and black spruce that grow here can reach forty to sixty feet in height or more. *Sphagnum* moss and other plants are common; the soil has a pH of 4.5.

Wisconsin Wetland Habitat Card

6 Tall grasses and other kinds of plants grow up out of the shallow water. The ground is usually covered with water but is sometimes dry. The plants provide food and places to hide for many kinds of animals including fish, invertebrates, muskrats, and lots of birds. This habitat is often at the shoreline of a pond or lake.

Wisconsin Wetland Habitat Card

7 Where tall hardwood trees grow in low-lying areas, the ground may hold water for part of the year. In the spring, many beautiful wildflowers grow here, and frogs and salamanders find wet places to lay their eggs. The soil stays moist all year.

Wisconsin Wetland Habitat Card

8 In this low, moist field you are surrounded by bright purple blazing star, big elephant-eared leaves of prairie dock, small wild onions, and many other colorful wildflowers. Native grass species are also common.

Wisconsin Wetland Habitat Card

9 Old lakebeds and other low areas that fill with rainwater sometimes accumulate layers of partially decayed plants called peat. At first glance these places might look dry, but their moss-covered floors actually hold a good deal of fresh water just below the surface. The ground here has a pH of 6.0 and feels very spongy. Some shrubs, tamarack and spruce trees also grow above the sphagnum moss.

Wisconsin Wetland Habitat Card

10 This moist, marshy habitat has no trees. You test the soil and find the pH to be around 9.0. Some beautiful, rare plants grow well in this harsh alkaline soil where other plants can not grow. White calcium deposits can be seen on the soil surface.

Wisconsin Wetland Habitat Card

11 The ground is not always covered with water in this habitat where sedges and grasses form hummocks in the shallow water. Small streams wind through the small, shrubby red osier dogwoods and willows. Many waterfowl, amphibians, and invertebrates live here.

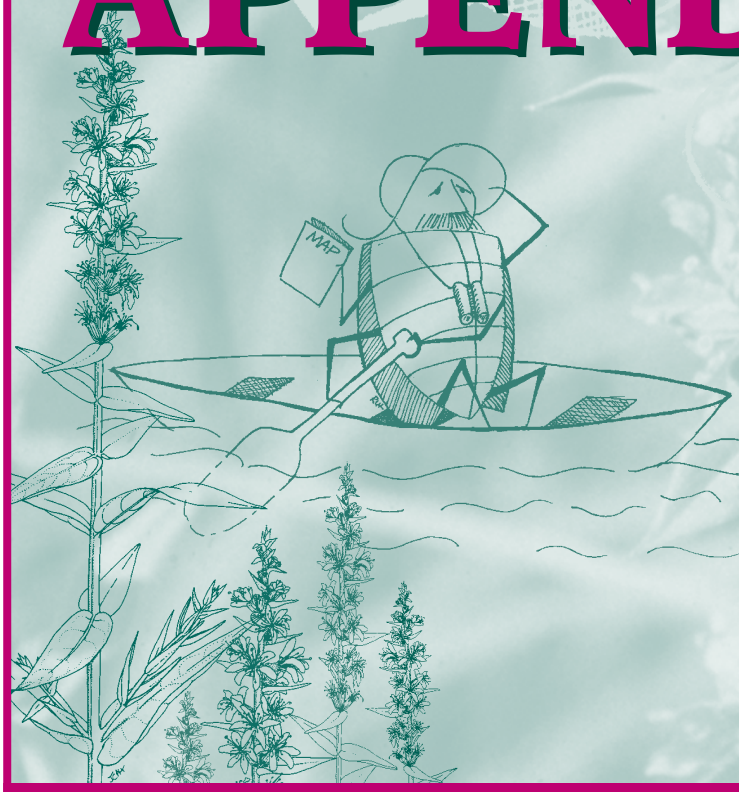
Wisconsin Wetland Habitat Card

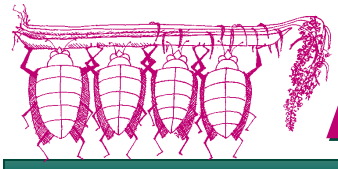
12 During the spring, these tall trees are flooded with water. Some of the areas around here keep ephemeral ponds well into July. In late summer and fall, the ground is often very dry.

Galerucella

Lythrum salicaria

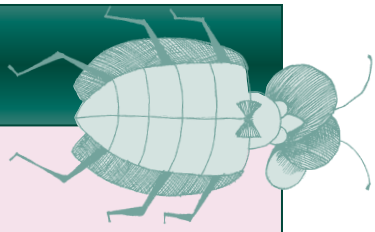
THE APPENDICES





APPENDIX 1

History and Distribution of Purple Loosestrife in Wisconsin



HISTORY AND DISTRIBUTION

The earliest confirmed report of purple loosestrife (*Lythrum salicaria*) in North America was in 1814, in wet meadows in Canada and the northeastern United States, though it probably arrived much earlier. It was probably first introduced from Europe and Asia as a contaminant in ship ballast and quickly established along the eastern seaboard. Canal construction evidently allowed it to move inland quickly. Expansion up the St Lawrence contributed to its move westward into the upper Great Lakes between the late 1890s and early 1900s. Maps in 1900 place it both in the Upper Peninsula of Michigan and Chicago. Use by the horticultural trade and beekeepers facilitated the geographical spread of purple loosestrife.

The plant made it into Wisconsin by the 1920s or earlier and was being used in gardens then. At about that time, purple loosestrife was being recognized as a pest in the East. Purple loosestrife became naturalized in the state, but was present at very low numbers for many years. By 1940, herbarium records show that purple loosestrife occurred in several locations around southeastern Wisconsin. By 1980, purple loosestrife had spread throughout the state. Stuckey (1980) believed that the plant typically becomes common and problematic 20-40 years after initial establishment.

By the early 1980s, purple loosestrife was recognized as a major problem in the Midwest and a developing concern among Wisconsin professionals and citizens. Though most state wetlands were still free of the plant and most populations were small, purple loosestrife had firmly established itself in large numbers throughout Waukesha and eastern Jefferson Counties, Horicon Marsh, Crex Meadows, and the Fox River Valley, especially in the Green Bay area. A newly established Purple Loosestrife Task Force developed a campaign to map locations of infestations, educate others about the problem, correspond with nearby states on the matter, and push legislative action against trade and cultivation of the plant.

R. QUEEN

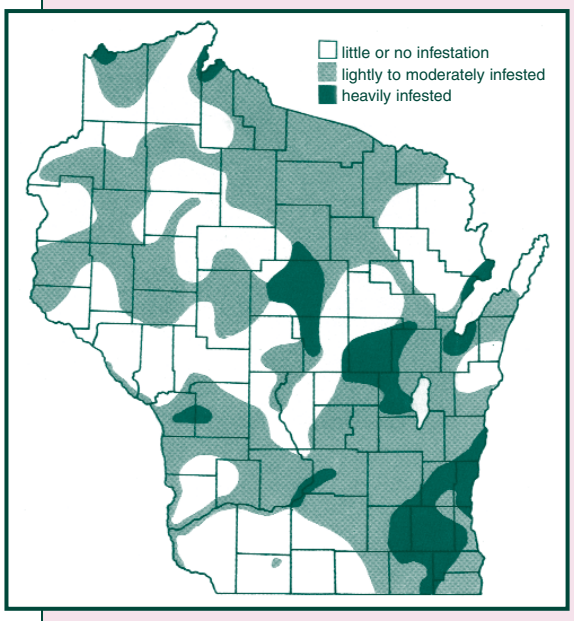
In the mid- to late 1980s, the Wisconsin DNR undertook a statewide census of purple loosestrife locations. Though never completed, the census resulted in most of the location information currently known. The census produced the map depicted in **Figure A.1-1**. These data confirmed the severity of the problem in the above areas and revealed additional "hot spots," including the central, and parts of the lower, Wisconsin River valley, the LaCrosse area, the Wolf River region, and the Superior and Ashland areas along Lake Superior.

Appendix 1.

Given early location information it seems likely that purple loosestrife first entered the state in the southeast corner and later in the Northwest, especially through transport by Great Lakes shipping, gardeners, and possibly beekeepers. The worst areas of infestation are still around river systems and shipping terminals near Milwaukee, Green Bay, and our Lake Superior ports.

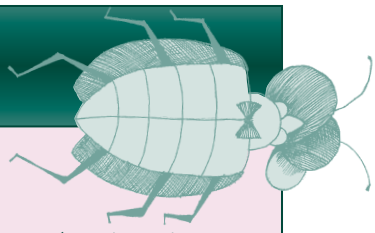
Purple loosestrife is now found in large numbers in central and western drainages in the state where disturbance has been high. It is likely that loosestrife seeds have been spread far and wide by people, animals, wind, and water. Purple loosestrife numbers have been increasing more recently in many wetlands throughout the state, but especially in areas where wetlands are most plentiful and heavily visited, namely along northwestern rivers, such as the Yellow, Namekagen, and St. Croix, and in the Northern Highland lakes area of north central Wisconsin.

Purple loosestrife has now been reported from every county in the state and it is apparent that no wetland anywhere in Wisconsin is safe from infestation, regardless of surface drainage connections to other infested areas. The small size and large quantities of seed, the ease with which people can move loosestrife fragments on vehicles, other machinery, and footwear, and the fact that birds have been documented carrying it in mud on their toes, virtually assure that every wetland is likely to receive this invader. There is also still a problem with gardeners using and sharing purple loosestrife plants.



Unfortunately, the current status of purple loosestrife in the state is unclear, though it has obviously expanded in the vast majority of areas where it was found by the 1980s Wisconsin DNR survey. Work is now going on to update these data and make them available to the public. As a start, these data, combined with some more recent location information, are now collected in a geographic information system (GIS) and made available on an Internet web site set up by the Great Lakes Indian Fish and Wildlife Commission (GLIFWC) at **www.glifwc-maps.org**. (Directions for accessing and using the web site follow at the end of this appendix.)

Figure A.1-1. Purple loosestrife distribution in Wisconsin (based on 1988 Wisconsin DNR data).



The Wisconsin Wetlands Association (WWA), GLIFWC, Wisconsin DNR, and University of Wisconsin-Extension have agreed to continue updating this information and, with funding from the Wisconsin Coastal Management Program and private sources, began to do so in the summer of 2002. More than 130 volunteers were trained to conduct a survey of loosestrife locations in Wisconsin's coastal counties. The survey used a systematic coverage of roads (and waterways where volunteers were able). WWA directed the survey and now plans to enhance and expand the survey effort to cover all of the state more thoroughly over the next several years. Many more volunteers in all counties will be needed for this effort. Please contact WWA (608-250-9971), if you are interested in participating. Statewide cooperators who raise and release beetles with the Wisconsin DNR's Purple Loosestrife Biological Control Project are also helping in the effort by reporting observed loosestrife infestations. All citizens are encouraged to report sites by writing or calling the project office at Wisconsin Purple Loosestrife Biological Control Project at Wisconsin DNR Research Center, 1350 Femrite Drive, Monona, WI 53716 or **brock.woods@dnr.state.wi.us** or 608-221-6349.

Reference: Stuckey, R. 1980. Distributional history of *Lythrum salicaria* (purple loosestrife) in North America. *Bartonia* 47:3-20.

INSTRUCTIONS FOR USING GLIFWC'S PURPLE LOOSESTRIFE WEB SITE

This Internet web site is the key to finding many purple loosestrife infestations in Wisconsin. The site includes all of the Wisconsin DNR's 1980s survey sites, as well as many newly identified sites. It is the easiest way to find a local source of purple loosestrife rootstocks required for rearing *Galerucella* beetles and sites with suitable characteristics for releasing those beetles. Unfortunately, many loosestrife sites remain unknown to Wisconsin DNR and GLIFWC and therefore are not shown on the map. If you know of any such sites, please report them. WWA survey sites will be added as they are found.

Some *Galerucella* beetle release sites are also located on the map. Most sites from the Wisconsin DNR and GLIFWC and some cooperator sites are shown; however, many of the latter are not because cooperators have not yet submitted their release site data to Wisconsin DNR. This information is important for estimating where the biological control need is greatest, as well as identifying where collectable *Galerucella* beetles may be found for future local rearing efforts. If you know of unreported sites please report them or encourage the appropriate cooperator to do so.

Appendix 1.

To use the map, locate a purple loosestrife site its by proximity to familiar roads, lakes, watercourses, etc., then bring up detailed written information, including location, for the site, as outlined below. Release sites may have instigator contact information listed.

1. Access the web site at **www.glifwc-maps.org** and the map by scrolling down to and clicking on "Purple Loosestrife Distribution and Control."
2. The site opens with the top icon ("zoom in") of the left-hand vertical list highlighted with a red box. Simply click on an area of particular interest to zoom in. (If this does not work, first click on the "zoom in" icon on the left side of the page. Note there is also a "zoom out" icon that you must highlight to zoom out.)
3. If the level of detail is not fine enough to select an individual site, click again to zoom in further until you find a site of interest.
4. Click on the "information" icon (fourth from the bottom at left) to highlight location data for a point on the map.
5. Click on the point you want the information for and it should appear across the top of the screen.
6. Read the data for the site in the box at the top of the page. The original data are usually township, range, section and, sometimes, quarter section* information and can be used to identify the specific area on any U.S. Geological Survey topographic map or in the *Wisconsin Atlas and Gazetteer*. (Data with latitude and longitude coordinates may be original or may have been added later for some points. These can also be used to locate sites on maps.)

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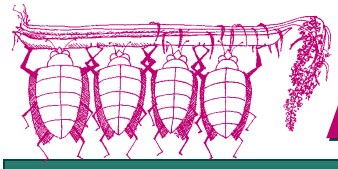
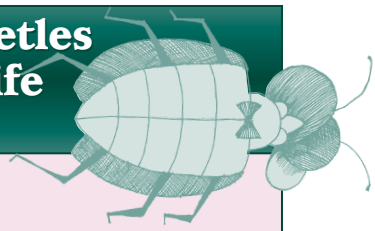
* Wisconsin is divided into townships that are approximately square and 6 miles on each side, labeled by township numbers running north and south, and range numbers running east and west. Thus, "R" numbers along the bottom of a map show range (e.g., R 12 E) and "T" numbers along the sides of a map show townships (e.g., T 16 N). Find the township that intersects both these numbers, given in the bottom box of data for any area, and you will identify the township where that area is found. Each township is divided into 36 1-mile squares, called sections, and numbered from 1 to 36, starting from 1 in the upper right corner of the township and ending with 36 in the lower right corner. The section number identifies which of these contains the plants. If a quarter section is also identified, it will be the area of that section with the plants. The finest resolution of this township/range system is a quarter section, or about 160 acres. To determine the exact location of the loosestrife, find a likely local map location therein and explore it on foot. In the future, sites should be located with latitude/longitude data that are more exact and easier to use with Geographic Positioning System (GPS) units.

EXAMPLE: Site #19872329 is at "26N6E19" and "NE". This means the site is in Township 26 North, Range 6 East, Section 19, in the northeast quarter of that section. (Note additional site details are also given.)



APPENDIX 2

How to Raise and Release *Galerucella* Beetles Outdoors for Controlling Purple Loosestrife in Wisconsin



The Wisconsin DNR's Purple Loosestrife Biological Control Project (WPLBCP) will send you beetles for propagation so you can increase their numbers faster than the beetles can on their own, as well as place them where beetles are needed most. You can rear beetles by ensuring ample food, good living conditions, and no predators, and by carefully choosing release sites. Biological control beetles remain too rare in the state to adequately control purple loosestrife. They are still needed in many more infestations to do the job.

Raising and releasing *Galerucella* beetles is easy and fun. Simply, it includes collecting purple loosestrife roots from your local wetland, potting the plants and growing them in a child-size wading pool, adding beetles when plants are 2 feet tall, and dropping the pots off in your local loosestrife patch about a month later. There are a few crucial details laid out here that will help you succeed in propagating your beetles, yet this is also a project with parts that can be accomplished in many ways. You have the freedom to do it as it suits you—as long as you produce lots of healthy and hungry beetles! Please read this guide carefully, then make the process your own by accomplishing the necessary steps in your own way. If you find an effective and unique way of doing so, please share it with us. Check the Wisconsin DNR's web site annually for updates to this and other appendices.

A PROJECT TIMELINE: GETTING READY

In order to plan ahead, please consider the following typical outdoor rearing timeline, starting in the fall (**Figure A.2.1**). The timeline is based on the biology of the plants and beetles, our temperate climate, and your location, and should result in the healthiest beetles. It is possible to rear beetles indoors earlier in spring and entirely within the school year. Preliminary research, however, suggests that beetles produced this way are less successful in establishing outdoors. Even if true, all produced beetles have value and the additional educational benefits from more student exposure to the whole rearing process may be worth the tradeoff. More research will be done and, if warranted, a separate indoor rearing appendix will be produced and winter beetles made available.

A. HUDSON

Marking purple loosestrife plants with colored flags in the fall helps you locate them in the early spring.

In the summer before spring rearing you should become familiar with wetland plants to be sure you can correctly identify purple loosestrife. In the fall, search your local wetland for purple loosestrife plants that you want to use

Appendix 2.

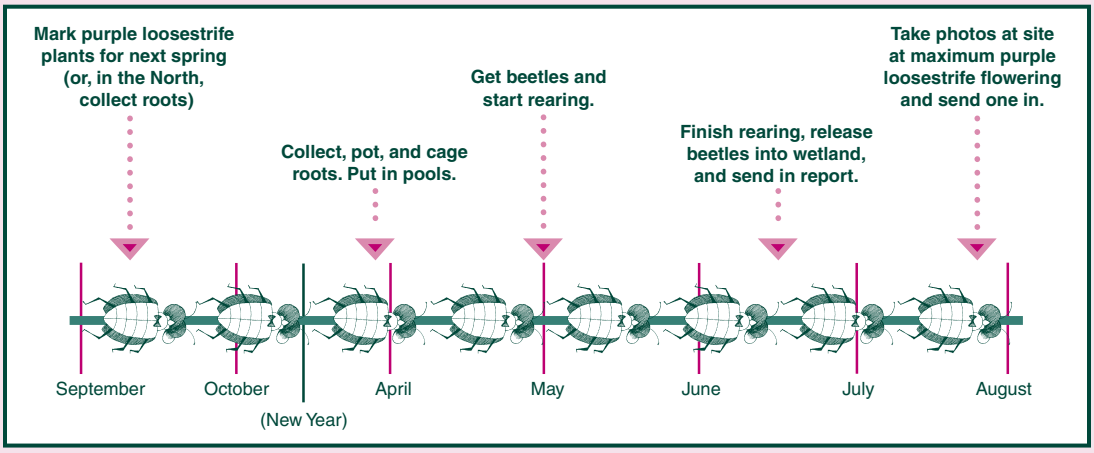


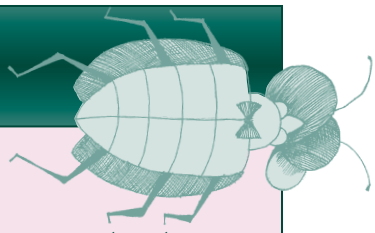
Figure A.2-1. Yearly beetle rearing and maintenance activities.

and mark them with brightly colored plastic flagging. At that time, plant stems and leaves should still be present to help you choose the correct and best plants. If you need to find a site, access the Great Lakes Indian Fish and Wildlife Commission's web site (see Appendix 1 for instructions on using the site) or consult the WPLBCP.

If you live north of Wausau, consider digging your plants in the fall after a few hard frosts, rather than in spring when a late thaw could delay digging. An early start for your plants is important for ensuring that they grow large enough to receive beetles when they become available. Consider buying a wading pool in fall as well, since they are generally less expensive then and often unavailable until late in the spring.

Winter is the time to collect needed tools and materials. Appendix 3 lists everything you might need (some materials may be available free from the WPLBCP). This is also the time to sew your netting into sleeve cages since you will need them as soon as you pot your plants. Cage construction is simple. Start with fabric pieces 46 + inches by 78 inches. Fold each piece along the short side to make it 23 + inches by 78 inches (doubled). Sew down the 78-inch open seam, tapering the bottom end of the cage to match the circumference of your pots. Sew each seam again with a zigzag stitch to strengthen it.

In the spring, dig roots as soon as wetlands thaw and before any shoot growth, typically early April in the South and mid- to late April in the northern part of the state. About 4 weeks later, usually early to late May, your plants need to be around 2 feet tall to receive beetles.



In mid-summer, about 4-8 weeks after adding beetles, you will release your new beetles and send release site information to the WPLBCP (see Appendix 5.) It is very important to take two photographs of your site several weeks later, when the plants are in fullest bloom, and send one photo to the WPLBCP. The other will give you a record of the early site for comparison with photos taken in later years to easily see satisfying changes in the site's vegetation. Monitoring procedures are outlined in Appendix 8.

COLLECTING ROOTS

Purple loosestrife is a state-listed noxious weed. Before cultivating the plant, you must send a copy of your signed permission form/permit (Appendix 4) to the Wisconsin DNR in order to raise plants legally. The only legal purpose for cultivating loosestrife is to produce biological control insects.

Purple loosestrife is a perennial, with only the above ground plant parts dying each fall. The aim in growing plants from pre-existing roots is to quickly produce the largest plants with the most foliage possible in order to maximize beetle feeding in the spring and summer.

Dig roots *immediately* after your wetland is ice-free. This both prevents damage to tiny new shoots during transplanting and allows you to set up the best conditions for fast early growth of the transplants. If you have a northern Wisconsin site, where roots are often frozen late into spring, consider collecting them the previous fall. You must then store them some place moist and cool over the winter. This may be done outdoors under a shaded tarp or in a water-filled pool, or indoors under moist burlap at 40 degrees or lower and dark, such as in a root cellar. Always dig more roots than you need because many will not survive until spring. If a late spring is delaying your digging, you can travel to a southern location to get roots. You can locate appropriate sites on the Great Lakes Indian Fish and Wildlife Commission's web site (see Appendix 1 for instructions on using the site) or by consulting the WPLBCP.

Starting with large roots is critical, so *choose the largest roots* that will fit into your pots to produce the most foliage possible and avoid premature plant death from larval feeding. Gauge the size of a clump by the number of stems from the previous growing season. A clump with 6-8 stems is probably large enough. Generally, more stems work better. Treat the clump as a single plant, though it is just as likely to be several.

Choose a wetland with good footing and vehicle access since roots are often heavy. Plants in friable soil, sandy soil, or standing water are usually the easiest to dig. Clip the old stems of a clump, leaving a "handle" of about 8 inches. Use a shovel to cut, or a fork to loosen, around the outer base of the clump and lever the roots out by pulling up with your legs and rocking backwards. A large clump can be pulled or cut apart if it is too heavy to carry or too big for a pot, especially if it is more than

Appendix 2.

one plant. Clip the remaining stem stumps and pull off as much soil, other plant roots, organic matter, and dead loosestrife roots (black and brittle, on the bottom) as possible and leave this material in the wetland. Haul roots out of the wetland and transport them in garbage bags or tubs for ease of carrying and to prevent spreading plant parts or seed-contaminated soil. Wear appropriate boots and clothes, including protective eyewear.

Transplant at least 12-15 roots for each 10 growing plants desired. Extra plants will be especially useful for over-wintering captive beetles on-site.

PHOTOS: B. WOODS

Top: A garden fork can be used to loosen purple loosestrife roots before pulling them up. Note the flagging from the previous autumn.

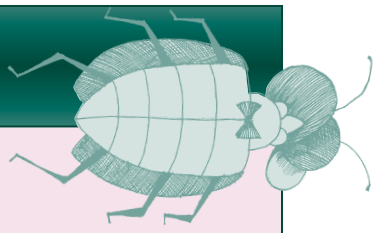
Bottom: Planting a dozen or more stems per pot will help ensure adequate food for the *Galerucella* beetles.

POTTING ROOTS

In an empty pool, mix water with your potting soil until it is thoroughly moist. Fill each pot with at least 3 inches of soil, adding more, if necessary, for the crown of each odd-sized root to be at the same height as the others, and a couple inches below the top of its pot. Sprinkle in a teaspoon of slow-release fertilizer (if not already in the soil mix) and mix it with the top inch of soil.

In another empty pool or container, spray-wash each root with a garden hose to remove most of the remaining organic material and mud, especially from the root crown, to get rid of any plant or insect predators and their eggs. Transfer waste material from this process back to the original wetland or to a capped landfill to avoid spreading loosestrife.

Place the largest root mass possible into each pot. If necessary, several small roots can be combined to produce the necessary 6-8 new stems. Clip any jutting root tips to allow packing in more root mass. Pack each pot with soil to within 2 inches of the top, filling all air pockets around the plants' roots. Larvae need to be able to penetrate the soil surface, so do not pack the soil too firmly. Water sparingly at this time to help settle the soil surface. Starting with saturated soil reduces the need to water. Hereafter, always water by filling the pool, not the pots, to prevent washing soil and fertilizer into the pool water.



POOL SET-UP AND PLANT CARE

Place a net sleeve cage over each potted plant *as soon as possible*. This protects the plant from damage and infestation by plant or insect predators. The cage must be securely closed at both ends. Duct tape one end of the cage to the dry pot top, above the water line. (You may use a draw cord or large rubber band to secure the net over the top of the pot, but adding tape will prevent wind from blowing the net off.) Try to leave as much fabric above the tape as possible to give the plant maximum amount of room for growth. Tie the top of the cage closed with a cord or wire, place the pot into a pool and suspend the bag from a support. The net cages must be supported to allow plants to grow unhindered. Many kinds of support systems will work (**Figure A.2.2**).

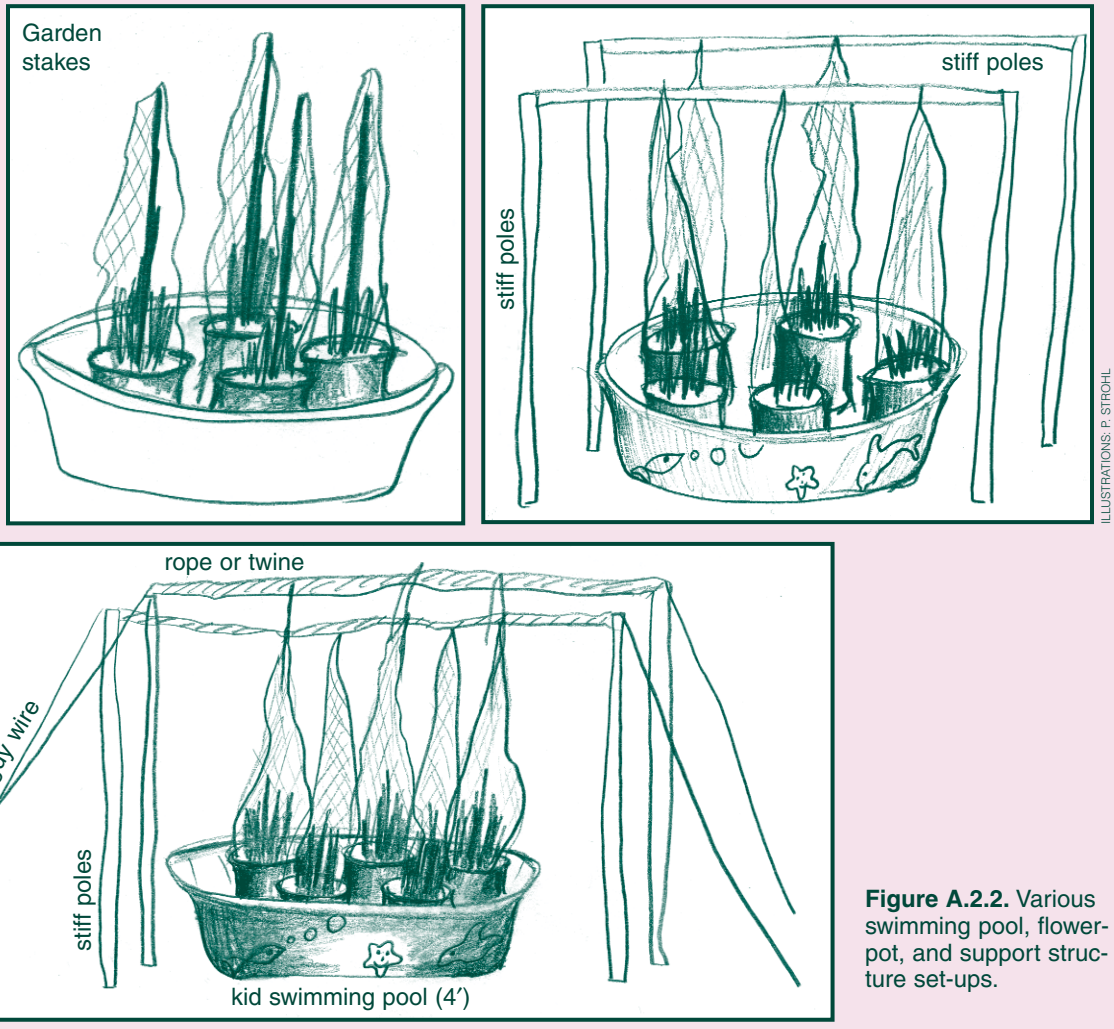


Figure A.2.2. Various swimming pool, flowerpot, and support structure set-ups.

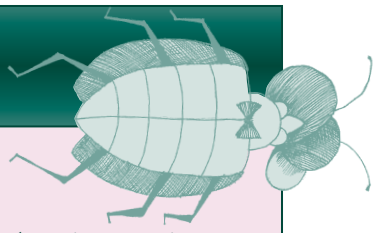
Appendix 2.

These range from a thin post, such as conduit, inside of each cage to exterior post systems with suspended cross members. (Interior supports should only be used where wind is minimal since they often allow pots to blow over). Guy lines can give added stability to any system.

Place pools in full sunlight, but out of strong winds. Arrange pots around the perimeter of a pool to give each plant maximum sunlight. Five to six pots fit around a 4-foot pool with extras in the center. Two of these pool set-ups are the best option for rearing 100 beetles. They are also easier to transport and offer more versatility in space arrangements. Ten pots also fit around a 5-foot pool with ample center room for extras, but

PHOTOS: B. WOODS

Cooperators use a variety of materials, techniques, and set-ups for rearing *Galerucella* beetles.



less sunlight may reach each plant than with 4-foot pools. At least one plant in a project should be cage-less to attract any escaped beetles. Other extra plants should be caged as replacements for weak plants.

Always keep several inches of water in the pools containing the plants. Check the pools daily, even on weekends, if the weather is hot and sunny. Drill drain holes several inches up a pool's sides, if necessary, to ensure that the maximum water level is never higher then 2-3 inches below soil heights, since pupating beetles do poorly in saturated soils.

You can eliminate mosquito larvae by periodically draining or flushing pools, or by putting in a few native mud minnows or goldfish, both of which survive in low oxygen environments. Frogs may appear; they may also eat mosquito larvae. You may have to replenish any of these critters if water levels drop too low or local predators such as raccoons eat them. Do not let non-native goldfish loose into the wild.

Plants need about 4-6 weeks, depending on weather conditions, to grow 2 feet tall and be large enough for beetle introductions. You may grow them indoors to shorten this time, but move them outdoors before adding beetles. Crowns take 1-2 weeks after potting to begin to grow, but then grow quickly. When stems are 12-15 inches tall, spread the small leaves at the tip of each growing point and carefully pinch it off. This stimulates the growth of lateral stems, provides more foliage, and helps keep plants from growing too tall for their cages.

RAISING YOUR BEETLES

When around 2-feet tall, plants are ready for beetles. Let the WPLBCP know ahead of time when you *expect* this to be and the program will send your beetles on or soon after that date. (There is a small, tax deductible donation to pay for delivery that should be sent to the WPLBCP with your application; see Appendix 4.) Placing beetles on plants that are too small or have too few stems or too little foliage can result in reduced beetle production and even premature death of the plant. This situation requires early beetle release.

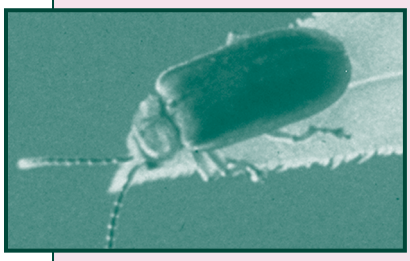
Beetles will come to you either shipped overnight from Madison or delivered in-person by Wisconsin DNR or UW-Extension staff. Once you receive them, put the beetles into

B. WOODS

Cooperators receive about 100 beetles for rearing and release. Beetles are mailed or delivered by WPLBCP staff.

Appendix 2.

L. REGNI



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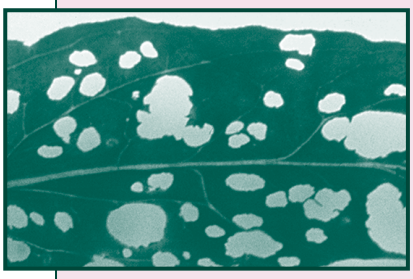

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Top: Using an aspirator or similar device makes moving the beetles easy and prevents you from harming them.

Center: Cooperators begin their rearing efforts with adult *Galerucella* beetles.

Bottom: Adult *Galerucella* beetles "skeletonize" leaves.

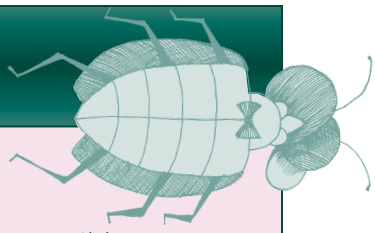
your cages as soon as possible. If you must delay, keep the beetles cool and out of direct sunlight, especially if they remain in the shipping container or the day is hot. If the delay is overnight, open the shipping box and bag inside to give the beetles fresh air. Gently knock the beetles away from the bag opening first since they will be eager to escape. Keep the shipping container, unless instructed to return it.

When you are ready to transfer beetles to your cages, use an aspirator or similar device to move 10 healthy beetles to each plant. If there is any reason to suspect spiders or other predators might be on your plants (e.g., your plants were not netted immediately after transplanting), check them over carefully right before adding the beetles. Open the top of each sleeve cage and simply drop the beetles in. Tightly cinch the tops closed and re-suspend the cages. Avoid using fingers or tweezers to handle the insects. Divide any leftover beetles among your larger plants. As soon as beetles are on your plants it is time to decide where your new beetles will be released.

You will see your beetles' four life stages if you watch carefully over the following 4-8 weeks. Many web sites listed in Appendix 9 have color photos that will aid you in identifying them. Note that temperature and weather conditions are important factors in the beetles' activity level and growth rate.

Old adults that you receive are from the previous year and are dark brown with a black stripe along the edge of each wing cover. They are 4-6 mm in length and about half as wide. They over-wintered at the soil surface or soil litter either in a wetland or surrounding uplands and have recently been collected in the field as they emerged to feed and mate. They will live about 6 weeks after emergence and each female will lay about 10 eggs each day for 30 days. Adult beetles "skeletonize" leaves by chewing many small, fairly round holes in them.

If *no* adult beetles appear to be present after the first week (also indicated by lack of leaf damage), look inside the cage, especially in the lower parts of the plant and along the soil for live adults and insect predators. Remove or kill



any of the latter. If neither is found, check the cage for holes or other possible means of escape. Check your cage-less plant for escapees and return them, once any means of escape has been fixed.

Eggs are tiny (less than 1 mm) and cream colored, with an uneven black line of frass (insect excrement) deposited on them. They are usually laid in bunches, often along the edge of adult feeding damage on both stems and leaves or in leaf axils. Humidity is important for egg hatching so make sure pools always have water in them to keep humidity high. Eggs hatch 2-3 weeks after they are laid. If you see no eggs, but adults are present, you may have a poor mix of beetle species (there are two) or genders. Try mixing with adults from a cage with lots of eggs.

Larvae are very small (about 1 mm) and hard to see when newly hatched. Larval damage in the shoot tips, called "tip-feeding," should be obvious early on, especially when accompanied by frass. Larvae are yellow with a dark head capsule and molt five times, each time increasing in size. Over 80% of larval growth occurs in the 4^{th} and 5^{th} larval instars. Their feeding damage is described as "window paning" because the leaf tissue is left brown, thin, and translucent, unlike the holes left by adults. After 2-3 weeks of feeding, large 5^{th} instar larvae move to the soil to pupate. If any plant turns completely brown while larvae are still visible, place that plant into the field immediately and check your other plants daily for the same problem, especially any that are smaller or had many eggs.

Pupae are the transformation stage between larvae and new adults. When most larvae seem to have disappeared, they are likely in the top inch of soil as pupae. During the pupation period, do not allow the upper layers of soil in your pots to be saturated with water for very long or many pupae will not survive. Some pupae manage to end up floating in the pool water; carefully retrieve and return them to the soil in a cage. After 2-3 weeks as pupae, teneral adults emerge from the soil.

New adults (tenerals) will emerge from the soil up to 100 times more numerous than the number of old adults started with 6-8 weeks earlier. They are usually light tan with no dark coloration on their wing covers and are easy to tell apart from old adults, with whom there may be a very slight over-lap in time. They collect at the top of each cage trying to disperse, especially on sunny days. Numbers are low at first, but hundreds more may appear every day, so *place a pot in the field as soon as any are seen in its cage*. Teneral adults will not survive long if plants have turned brown from larval or other adult feeding. In this case, add fresh loosestrife stems (inserted into florist clips with water) to the cages to feed them for a brief time, but release the beetles as soon as possible.

Appendix 2.

B. WOODS

Cooperators transport their potted purple loosestrife plants and *Galerucella* beetles to suitable wetland sites.

RELEASING BEETLES AND FOLLOW-UP

Release your beetles when the *first* new adults appear in your net cages, but decide on suitable release sites much earlier. Ten old adults produce up to 1,000 teneral adults per pot, for a total of 8-10 thousand tenerals when you start with 100 old adults. This is enough to start 4-5 small colonies, since you should put out a minimum of 2,000 beetles (usually 2-4 pots) on a site to start a viable population there. However, the best strategy the first year is often to set up a couple insectories, which are small, high quality sites for producing new local propagation stock within 2-3 years. Such sites have 50 + healthy, mature loosestrife plants, but are ½ acre or less in size and are well separated from larger loosestrife infestations. Beetle numbers can build up quickly and stay concentrated on such sites, making it both easy to collect breeding stock as well as see great results! These sites should also have landowner assurance of site security, good access and footing, be free from insecticide spraying (e.g., for mosquito control) for at least a year, have only very short or no summer flooding, and be places from which the loosestrife is unlikely to infest new wetlands.

If you wish to try producing your own propagation stock for the next year, for either spring or winter (indoor) rearing, you will need to over-winter captive beetles retained from your first year's rearing. Appendix 7 includes over-wintering instructions.

After setting up insectory sites the first year, or if no further rearing will take place, you can place beetles on any site where no other controls are practical. For more information on site choice, consult Wisconsin DNR or UW-Extension personnel. You can also refer to the "Wisconsin DNR's Purple Loosestrife Control Recommendations and Traditional Methods" in Appendix 6 and other publications like the brochure "Purple Loosestrife: What You Should Know, What You Can Do" (available on the web; see Appendix 9).

Appendix 2. *(continued)*

B. WOODS

Clustering 2-3 pots around healthy, wild purple loosestrife plants gives the newly reared beetles "field" food and encourages their colonization of the wetland.

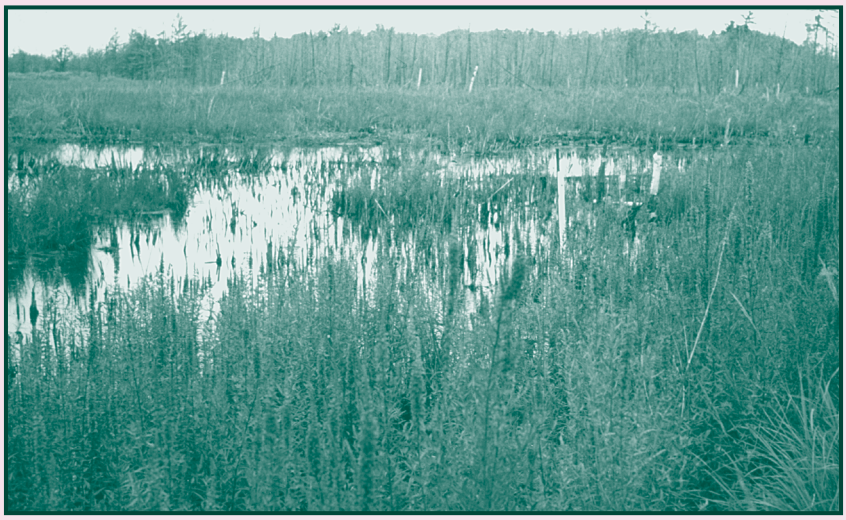
Transport potted plants and cages together. Ensure that beetles arrive in good condition by avoiding jarring (as in the back of a pick-up truck) and high temperatures. Fold plants and cages over gently if space is small, such as inside a vehicle.

Cluster pots within several meters of each other in a wetland with each pot adjacent to a large, healthy purple loosestrife plant. Remove the cages and shake out any adults onto nearby foliage. Bend the adjacent loosestrife plant stems into the spent, potted plant stems to allow any remaining larvae and new beetles to walk onto fresh foliage for immediate feeding. Mark either the ends of the site or the individual pot locations with PVC poles or flagging so you can find them again. Wait at least 4 weeks after the release before recovering your pots to allow the remaining beetles to emerge and disperse, or leave the pots until the spring.

If your beetle release is late, hundreds of beetles may congregate in your cage tops. If no green plant tissue remains, you must release them immediately or feed them, or they will die from the stress of starvation. A different release procedure is recommended to encourage these beetles to stay on the site after release. At the field site loosen the cage bottom from a pot, lift the pot and spread open one side of the cage. Insert several healthy field stems into the cage as you lower it and its pot to the ground. Snug the bottom of the cage around the pot and new stems as well as possible. This gives the new adults additional "field" food, getting them used to the site, before they are actually released. Remove the cages within 2-3 days, but leave the pots as above.

Appendix 2.

Taking photographs during peak loosestrife flowering allows you to document the effect of the beetles on purple loosestrife plants.



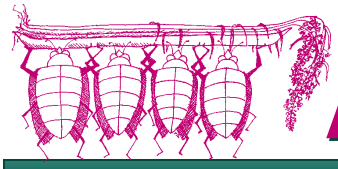
B. PRUKA

On the day of every release, please fill out and mail in a copy of the "Insect Release Field Report" in Appendix 5 for each release site. Return to each release site and take two photographs of it in late summer when the loosestrife flowering there is its most spectacular. Send one of your photos to the WPLBCP. This visual record in year 0 can be used to contrast with photographs of, or visits to, the same site in ensuing years to see how much the beetles are affecting the loosestrife. Larvae demolish flower buds and as their numbers build there should be less and less purple on the site at this time of year. Put a marker on the place you take the picture so later shots can be taken from the same spot. This is the easiest way for you to gauge your success with biological control.

New adults feed on leaves for a few weeks, but disappear around mid-August to over-winter in the leaf litter near host plants or in surrounding uplands. They and their feeding damage are often difficult to find then, but look carefully when you return to collect pots or take photographs. Finding beetles is easiest in the spring. Consider visiting your site then, especially as part of optional monitoring procedures (see Appendix 8).

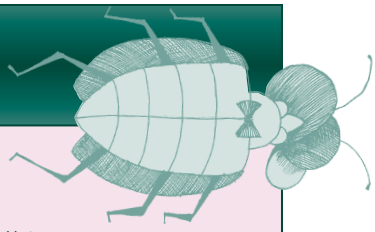
If you have any questions, comments, or suggestions about the beetle rearing process or want to send in site or release information and photographs, please write the Wisconsin Purple Loosestrife Biological Control Project at Wisconsin DNR Research Center, 1350 Femrite Dr., Monona, WI 53716 or call 608-221-6349.

Good luck!



APPENDIX 3

Materials for Rearing 100 *Galerucella* Beetles



This is an exhaustive list and you may not need, or need to purchase, all items. Some may be available for free from the WPLBCP (those indicated with an asterisk *) or elsewhere (such as pots from landscape businesses or buckets [that need holes drilled] from school lunch programs).

GETTING READY AND COLLECTING ROOTS

1. Wetland plant identification book(s) (see Appendix 9)
2. Map(s) to location of loosestrife roots and beetle release sites—Use a good local map after consulting the Great Lakes Indian Fish and Wildlife Commission's web site at **www.glifwc-maps.org** (see Appendix 1 for instructions on using the site)
3. Colored flagging in a roll or on metal stakes
4. Filled out, signed, copied, and mailed Wisconsin DNR permit letter (see Appendix 4)
5. Shovel or fork for digging and cutting roots
6. Plastic tubs (Rubbermaid® type) or plastic bags for hauling roots and waste
7. Pruning shears to cut off old dead stem tops and root tips, if necessary
8. Gloves, eye protection, rubber boots, and old clothes

POTTING ROOTS

9. 12-15 large purple loosestrife roots from a local wetland
10. 12-15 plastic pots, 10-14 in diameter *
11. About 2.5 cubic feet of high peat content potting soil (Fafard or a similar mix) *
12. 1 lb. fertilizer, slow release type like Osmocote 18-6-12, unless in the soil *
13. Hose and water source for rinsing roots, wetting soil, and filling pools
14. Two 4-foot child's wading pools, one 5-foot pool, or other suitable containers *

POOL SET-UP AND PLANT CARE

15. 24 yd. of 48+ in wide, no-see-um insect netting, thread, and sewing machine to make 11 net sleeve cages about 78 in long. Fold each piece of fabric along its short side and sew down the open 78-in seam, tapering the cage at one end to match the diameter of your pots. *
16. Duct tape (and perhaps bungi type cords) to attach cages firmly to pots *
17. Wire or string to tie cage tops shut and to supports; also for guy wires
18. 4 x 8 foot space in full sun or at south facing windows
19. 7-foot high cage support system for suspending net cages—clotheslines or conduit posts or a design of your own!
20. Dependable watering system

RAISING BEETLES

21. 100+ over-wintered beetles from the WPLBCP, field collected, or from other suppliers (see Appendix 4) *
22. Aspirator for catching and moving beetles *

RELEASING BEETLES AND FOLLOW-UP

23. Heavy-duty transportation for taking potted plants into the field.
24. Site release form (filled out and mailed to the WPLBCP on the day of release)
25. 3-11 PVC posts—for marking release site and photo point
26. Camera and film

Appendix 3.

OUTLETS FOR HARD TO FIND MATERIALS AND VIDEOS

Beetles for rearing or field release in July-August (Call for details):

- Cornell University, (607) 275-3786 (from New York State - minimum # to order)
- Beetles Unlimited, (608) 831-5601 (from Wisconsin – no minimums)

Insect netting (need approximately 78 inches of fabric/cage)
(WPLBCP supplies free with 3 year rearing):

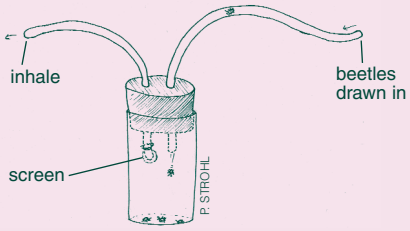
- Venture Textiles
  115 Messina Drive
  Baintree, MA 02185
  (781) 794-1400

  56 inches of white or slate; 500 yd. bolt $1.10/yard; lesser yardage is $1.10/yard plus $10 cut charge

Miscellaneous other supplies:

Aspirators (a small jar with hoses for collecting/moving beetles; about $7)

- BioQuip
  17803 La Salle Avenue
  Gardena, CA 90248
  (310) 324-0620
  fax: (310) 324-7931



Videos:

- "Restoring the Balance: Biological Control of Purple Loosestrife" – a summary of the problem, traditional and biological solutions and biological control safety.
- "Rearing of Biological Control Agents for Purple Loosestrife" – more rearing details.

$25 each (but volume discounts apply).

- Resource Center
  7 Business & Technology Park
  Cornell University
  Ithaca, NY 14850
  (607) 255-7660, ext. 2090
  Fax: (607) 255-9946

(Your local and school libraries can also get these on inter-library loan from the Wisconsin DNR library in Madison for free!)

APPENDIX 4

Permit for Growing Purple Loosestrife and Application to Produce and Distribute Biological Control Insects

Use the form on the following two pages to obtain permission to cultivate loosestrife and raise and release *Galerucella* beetles in Wisconsin. Obtaining this permit is a necessary first step for participation in Wisconsin's Purple Loosestrife Biological Control Program.

State of Wisconsin
Department of Natural Resources
PO Box 7921, Madison WI 53707-7921

Purple Loosestrife Cultivation Authorization and Biocontrol Insect Application

Form 3200-116 (R 5/03)

Notice: To be authorized to plant or cultivate purple loosestrife in the state for the purpose of controlled experimentation only, individuals must obtain authorization from the Wisconsin Department of Natural Resources (WDNR) or the Wisconsin Department of Agriculture, Trade and Consumer Protection (WDATCP). Any person who knowingly violates the requirement may forfeit not more than $100 for each violation, per s.23.235, Wis. Stats. WDATCP also oversees importation of organisms and this form may also authorize you to import and disperse certain purple loosestrife control insects under WDNR's permit from WDATCP, as long as in-state or authorized sources are used. You are required to provide complete information requested in order to obtain these authorizations. Personally identifiable information collected will be used for program research and management purposes and is not intended to be used for other purposes. Wisconsin's open Records law requires the Department to provide this information upon request (ss. 19.31 - 19.69, Wis. Stats.).

Instructions: Fill out all sections completely, except for Beetle Release Site Information if you do not yet have an intended release location. Under Beetle Rearing Information, be sure to indicate if you need beetles or cage nets from WDNR for propagation, and how many. Mail your completed forms, along with your donation check made out to WDNR (tax deductible) to cover beetle delivery, if needed, to: Purple Loosestrife Biocontrol Coordinator, 1350 Femrite Drive, Monona, WI 53716. Address questions about the program to the Coordinator at 608-221-6349 or brock.woods@dnr.state.wi.us.

The Department Coordinator will sign and return a copy of the authorization form to you. Both the applicant and Coordinator must sign the form for the applicant to be officially registered with the Department to legally grow purple loosestrife or distribute beetles under WDNR's permit. This dually signed permit:

- Affirms your interest in joining the Department's purple loosestrife biocontrol program.
- Indicates your support for program goals and your agreement to grow purple loosestrife plants, solely for the purpose of rearing the biocontrol insects, *Galerucella calmariensis* and/or *G. pusilla*.
- Authorizes you to acquire, raise and release these two beetle species under WDNR's permit from the Wisconsin Department of Agriculture, Trade and Consumer Protection (WDATCP), but only if they originate from the WDNR, other in-state sources or WDNR-authorized out-of-state sources.

As a biocontrol cooperator with WDNR you will join hundreds of other volunteers using a safe and effective, long-term strategy to control this aggressive, non-native plant. All your efforts will be crucial and greatly appreciated!

Updated program information is available on the WDNR web site at: http://www.dnr.state.wi.us (on various pages).

Applicant Information

Name	Organization (if any)

Street Address

City	State	ZIP Code

(Area Code) Home Telephone Number	(Area Code) Work Telephone Number	E-Mail Address

Beetle Rearing Information

Years in which I have reared beetles (or "0").

Check all that apply:

- ☐ I wish to rear beetles in spring, _____ (year).
- ☐ I would like _____ beetles from WDNR for propagation (number; 100 is typical; 10 beetles/plant)
- ☐ Send free netting for _____ cages (1 cage/10 beetles, plus 1 spare) Let me know if other equipment is available.
- ☐ I need a copy of the beetle rearing guide.
- ☐ My $30 donation to cover delivery is enclosed; or,
- ☐ I will collect my propagation/distribution stock or buy it elsewhere (not from WDNR). Send monitoring information.

Use this section for listing additional information you need.

Purple Loosestrife Cultivation Authorization and Biocontrol Insect Application

Form 3200-116 (R 5/03)

Beetle Release Site Information - Optional

Information in this section is optional, based on whether or not you have already chosen a beetle release site. Check all that apply. This will help us evaluate the site to determine if it is suitable for beetles and bio-control. The site meets the following criteria:

Category 1	☐	No purple loosestrife (PL) control at present
	☐	Control of PL going on, but it's ineffective
	☐	No chemical control over the last two years
Category 2	☐	50 plants-1 acre of PL (best for insectary: recollecting, rearing/dispersing insects)
	☐	More than 1 acre of PL
Category 3	☐	Good site access and footing (for follow up monitoring or collecting)
	☐	Access and/or footing poor
Category 4	☐	Site secure for at least several years (no other PL control or development planned)
Category 5	☐	Plants mature: at least several stems (3/16" plus diameter) per clump: 3' to 7' tall
Category 6	☐	More that half of the plants are PL (almost solid PL)
	☐	PL is half or less of all plants on the site
Category 7	☐	Water level is below ground surface all year or, if it floods, then not during June-August
	☐	Water below surface all year or, if it floods, not for more than several days at any time
Category 8	☐	Site not likely to spread seed to nearby, un-infested areas while beetle numbers increase

Severity of purple loose strife infestation in the area around your site is: (check one)

☐ Low ☐ Medium ☐ Severe

Site Location

Site Owner Name	Address	(Area Code) Telephone Number

Have you contacted your local WDNR or UW Extension agent about the site? ☐ Yes ☐ No

If YES, Name of agent contacted

Terms and Conditions of Permit

The cooperator agrees to the following requirements to participate in the WDNR Purple Loosestrife Biocontrol Program:

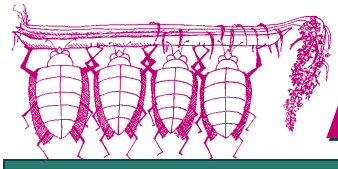
1. Raise purple loosestrife in a controlled setting to minimize the possibility of spreading the plant further through seed or plant parts; pinch off all developing flowers once larvae are done feeding; destroy unused plants/parts that not returned to loosestrife infestations.
2. Obtain permission from all landowners on whose property beetles will be collected or released.
3. Acquire for rearing or release, purple loosestrife foliage beetles (Galerucella calmariensis and/or G. pusilla) from WDNR or other Wisconsin suppliers, from Wisconsin sites, with landowner permission, or from any WDNR-authorized out-of-state supplier. (This includes Cornell University, New York, and the Illinois Dept. of Natural Resources and any other sources that may be added in the future.)
4. Furnish the WDNR with a complete list of all insect release site locations and landowners within one month of each release. Use the release site form # 3200-117, available from WDNR.

Applicant Signature	Date

WDNR Use Only

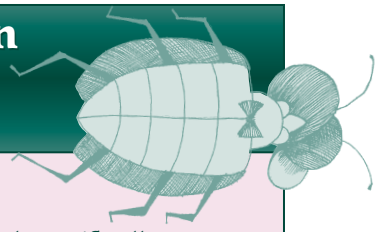
The State of Wisconsin Department of Natural Resources hereby issues this authorization to plant or cultivate purple loosestrife for biocontrol purposes, solely for the purpose of rearing the biocontrol insects as specified above.

WDNR Project Coordinator	Signature	Date



APPENDIX 5

Instructions for Recording Information on Purple Loosestrife Biological Control Insect Releases



Site Location: Please fill out the field report (next page) as completely and specifically as possible. Enter location (site name, city, county, etc.) in spaces provided. If global positioning system (GPS) latitude and longitude coordinates are available, enter this information in the spaces provided.

Contact Person and Legal Landowner: Provide the name, address, and telephone number of a contact person. This can be the person who releases the beetles or a local contact. If the contact person is not the legal landowner or the site is not on DNR managed wetlands, lakeshores, or rivers, please provide this information in addition.

Road Map: Photocopy a road map (preferably a county road map) to the site and paste it into the space provided. The *Wisconsin Atlas and Gazetteer* (Yarmouth, Maine: DeLorme Publishing) works well. Mark the location of the site. Add an arrow to the map to indicate which direction is north. If a verbal description of directions is needed, attach a written description to this page.

Site and Vegetation Map: Provide a map of the area with access roads, an approximation of purple loosestrife infestation outlined, other vegetation types, open water, creek, etc. Paste the map into the space provided. Indicate with Arabic numerals (corresponding to numbers under "Insect Release History" below), points of single or multiple control agent (beetle) releases. Add an arrow to the map to indicate which direction is north.

Photographic evidence of changes in vegetation over time can be a powerful tool for presentations or to reinforce quantitative data. One or several photo points should be marked in the area of insect release(s) using flagging tape or stakes driven into the ground. The position of these photo points should be indicated on your vegetation map with an arrow emanating from the photo point and in the direction the photo was taken. Take pictures once a year at the peak of the flowering period. Make sure to record which photos were taken from which location and when.

Insect Release History: Document the date, weather (temperature, cloudiness, wind speed), insect condition (good, fair, poor), insect species, life stage, and approximate number released. Assume a large, defoliated potted plant has 1,000 beetles on it. Use additional field sheets, if necessary. Code each release with an Arabic numeral and insert the number at the release point on the vegetation map. Update this field sheet as needed.

Submit Field Sheets: Submit a copy of your completed field sheets with maps and photos to:

Wisconsin Purple Loosestrife Biological Control Project
Wisconsin DNR Research Center
1350 Femrite Drive
Monona, WI 53716

Field report on next page.

State of Wisconsin
Department of Natural Resources

Purple Loosestrife Insect Release Field Report

Form 3200-117 (5/03)

Notice: Information requested on this form is required to document release of insects under the Purple Loosestrife Biocontrol project, authorized under s. 23.235, Wis. Stats. Personally identifiable information collected will be used for program research and management purposes and is not intended to be used for other purposes. Wisconsin's Open Records law requires the Department to provide this information upon request [ss. 19.31 - 19.69, Wis. Stats.].

Instructions: Submit a copy of your completed field sheets with maps and photos to:

Wisconsin Purple Loosestrife Biological Control Project
Wisconsin DNR Research Center
1350 Femrite Drive
Monona, WI 53716

Release Site Location Information (Fill in as completely as possible.)

Site Name	Observation Date

Nearest City/Village/Town	County

Latitude: DEG	MIN	SEC N	Longitude: DEG	MIN	SEC W	GPS Derived? ☐ Yes ☐ No

Elevation	Township N	Range E / W	Section	¼	¼ / ¼

Contact Name

Name	State	ZIP Code

Address	

City		Telephone Number	E-Mail Address

Legal Landowner - Required for release permission.

Name	State	ZIP Code

Address	

City		Telephone Number	E-Mail Address

Road Map to Site

Photocopy a road map (preferably a county road map) to the site and paste it into the space provided. Mark the location of the site. If a verbal description of directions is needed, attach a written description to this page.

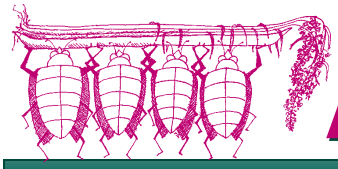
Site and Vegetation Map

Provide a map (hand drawn, if necessary) of the area with access roads, an approximation of purple loosestrife infestation outlined, other vegetation types, open water, creek, etc. Paste the map into the space provided. Indicate with Arabic numerals (corresponding to numbers under "Insect Release History" below), points of single or multiple control agent (beetle) releases.

Insect Release History

Document the date, weather (temperature, cloudiness, wind speed), insect condition (good, fair, poor), insect species, life stage, and approximate number released. Assume a large, defoliated, potted plant holds 1,000 beetles. Use additional fields sheets, if necessary. Code each release with an Arabic numeral and insert the number at the release point on the vegetation map. Update this field sheet as needed.

Date (mm/dd/yy)	**Weather** (temp, wind, clouds)	**Insect Condition** (good, fair, poor)	**Insect Species, Stage & Approximate No.** (adults, immatures, eggs, all stages)	**Position of Release on Map** (1, 2, 3, 4. . .)



APPENDIX 6

Wisconsin DNR's Purple Loosestrife Control Recommendations and Traditional Methods

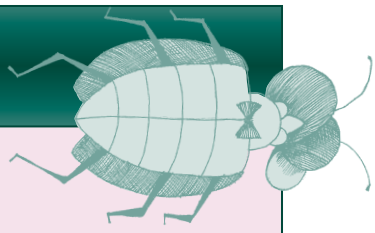
Effective long-term control of purple loosestrife in Wisconsin must include both traditional control methods as well as biological control. Each has its advantages and you must decide carefully which to use. No matter what you decide, the most important thing is to *start* controlling the purple loosestrife in your wetland *now*.

Use traditional methods for quick and effective control on all sites for which you have adequate resources and will be successful. These measures are labor intensive, and expensive on large sites, so *small or low-density sites* are most often controlled this way. These techniques will require additional annual vigilance. Even if all purple loosestrife is accessible, some plants will be missed and a soil seed bank ensures germination of new purple loosestrife plants for up to a decade. Thus, you must annually treat any missed or new plants. You should also destroy any purple loosestrife in surrounding wetlands to stop seed dissemination to your site. In fact, if your site is in an area surrounded by other loosestrife infestations, hand control may not be worth the effort. These methods can also be very disruptive to wetlands and, in addition to cost and chemicals, suggest a serious consideration of alternative biological controls.

Biological control must be started in all purple loosestrife infestations where there is no effective traditional control, no matter what size, though this is often on larger sites. Some small infestations should receive beetles, too, to serve as insectaries — sites for growing insects for propagation stock — unless purple loosestrife seed from these sites will infest other nearby wetlands. Biological control uses plant predator insects to control PL. It is inexpensive and natural and can become self-sustaining and self-disseminating with minimal disturbance to wetlands. However, set-up time is longer and its outcome less certain. An insect population must grow commensurately large to affect the local purple loosestrife infestation, a process that usually takes at least several years, may require several infusions of propagated insects, and may not work on some sites, especially if frequently flooded. Many biological control insect releases in Wisconsin, however, have been quite successful, showing good purple loosestrife control in 2-3 years. For more information, contact a regional Wisconsin DNR Aquatic Plant Management Coordinator or the Purple Loosestrife Biological Control Program Coordinator by mail at Wisconsin DNR Research Center, 1350 Femrite Drive, Monona, WI 53716, by e-mail at **brock.woods@dnr.state.wi.us,** or telephone at 608-221-6349.

Traditional controls and biological control may be used together on the same site (or area) as long as insects have foliage to eat and are not exposed to herbicides. One way is to cut stems just beneath the inflorescences to prevent seed production, but provide foliage. In fact, integrating controls may be the best plan, since some immediate purple loosestrife control is established while strong-flying biological control insects gradually become ubiquitous enough to find and control all loosestrife plants—perhaps eventually replacing all traditional controls!

Continued on next page.



TRADITIONAL METHODS

Preventing purple loosestrife from infesting new sites is the easiest control. Be sure local gardens have no illegal purple loosestrife plantings that produce seed. Monitor your sites (annually) and remove any small colonies or new young plants. Especially check areas near moving water, wetland/upland edges, storm sewer outlets or gardens that may have contained purple loosestrife. One mature purple loosestrife plant produces over 2 million seeds a season, so learn to recognize pre-flowering plants or search when purple loosestrife just starts to bloom. Destroy them before they mature, flower and drop seeds, which can start before flowering ends. Dispose of plants in a capped landfill, or dry and burn them. Composting will not kill the seeds. Keep clothing and equipment seed-free to prevent its spread. Take responsibility to remove new plants wherever you see them. (Get landowner permission first.)

Mechanical Control - Mechanical control includes cutting, pulling, or digging and drowning. Cutting is best done just before plants begin flowering. Cutting too early encourages more flower stems to grow. If done too late, seed may have already fallen. Since lower pods can drop seed while upper flowers are still blooming, check for seed. If none, simply bag all cuttings (to prevent them from rooting). If there is seed, cut off each top while carefully holding it upright, then bend it over into a bag to catch any dropping seeds. Watch for holes in your bags so you don't spread seed where you drag the bags.

Pulling and digging can be effective, but can also be disruptive by creating disturbed bare spots, which are good sites for purple loosestrife seeds to germinate, or leaving behind root fragments that grow into new plants. Use these methods primarily with small plants in loose soils, since they do not usually leave behind large gaps nor root tips; large plants with multiple stems and brittle roots often do. Dispose of plants as above. Drowning young purple loosestrife is effective if plants are *completely* submerged for a year (often after being cut to decrease height.)

Chemical Control - This is usually the best way to eliminate purple loosestrife quickly, especially with mature plants. Chemicals used have a short soil life. Timing is important: Treat in late July or August, but before flowering to prevent seed set. Dispose of plant parts as above. Always back away from sprayed areas as you go to prevent getting herbicide on your clothes.

The best method is to cut stems and paint the base cuts with herbicide. Cut low on the stem (about knee level) with one hand and apply the herbicide with a second hand, while carefully stuffing the plant top into a plastic bag with the third and fourth hands (a two person crew works well for this). The herbicide can be applied with a small drip bottle or spray bottle, which can be adjusted to release only a small amount. Try to cover the entire cut portion of the stem, but not let the herbicide drip onto other plants since it is non-selective and can kill any plant it touches. Glyphosate herbicides *Roundup* and *Glyfos* are typically used, but if it is very wet in the area use *Rodeo*, a glyphosate formulated for use over water. Stem applied

Appendix 6.

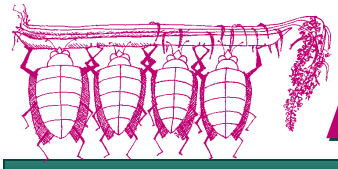
herbicides should be mixed to 20 to 40% active ingredient. Since you must treat at least some stems of each plant and they often grow together in a clump, all stems in the clump should be treated to be sure all plants are treated. Bag all cuttings since they can root if they come in contact with water or moist soil and dispose of as above.

Another method is using *very carefully targeted* foliar applications of herbicide (*not* broadcast spraying). This may reduce costs for sites with very high densities of purple loosestrife, since the work should be easier and there will be fewer additional plant species to hit accidentally. Use a glyphosate formulated for use around water. A weaker solution of around 1% active ingredient can be used and it is generally necessary to wet only 25% of the foliage to kill the plant. *Triclopyr* (*Garlon* 3A) is another herbicide that can be used as a foliar spray. It is formulated for use around water and does not harm grasses or sedges, but it has *not* received final approval from the U.S. EPA for wetlands. Wet most of the foliage if using this chemical.

You must obtain a permit from Wisconsin DNR before applying any chemical over standing water. The process has been streamlined for control of purple loosestrife and there is no cost. The appropriate person to contact is your regional Wisconsin DNR Aquatic Plant Management Coordinator (list available from biological control project). S/he will want to know about your site and plan, may make further suggestions, and will issue your permit.

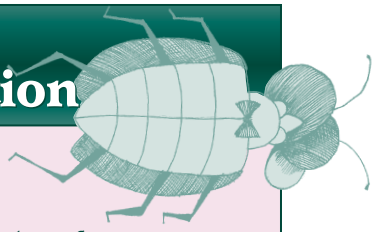
Chemicals, Tools, and Costs – Chemicals and tools to apply them are often available from local farm cooperative stores and garden shops. Your Aquatic Plant Management Coordinator may be able to help you locate a supplier nearby. If you cannot get the herbicides locally, a private business in DeForest, Wisconsin will ship them. Contact them by calling 800-362-8049.

Roundup is for drier sites and costs about $90/gallon. Buying in volume will save you money: 2.5 gallons of *Roundup* costs about $110. It requires no additives. *Rodeo* is for very wet sites and costs around $120/gallon. It must be mixed with a nonionic surfactant, about $18/gallon. Monsanto (800-332-3111) manufactures both of these glyphosates. *Glyfos* is a generic version of *Roundup* made by Cheminova (800-548-6113); if interested, call the company for a local supplier. *Glyfos AQ* is the equivalent to *Rodeo*, but may not yet be generally available. Concentrations discussed above are approximate since requirements are variable on different populations of plants in different situations. Test yours to be sure you use an appropriate amount of active ingredient. Call manufacturers or your local Aquatic Plant Management Coordinator if you have additional questions.



APPENDIX 7

Over-Wintering Beetles for Indoor Winter or Outdoor Spring Propagation



The best way to get *Galerucella* beetles for outdoor propagation is to collect them from small, successful field sites that you or others have previously established. Work is minimal and fecundity stays high, though timing is critical to collect them in sufficient numbers. Try to establish your own local insectory sites the first year you raise beetles and, in 1-3 years, you may have your own spring beetle supply.

You may also try keeping some *Galerucella* beetles captive over-winter from previous rearing efforts, for rearing beetles indoors in winter or outdoors in spring. Do this for only one year after starting with beetles collected from the field because fecundity soon drops. Also, results of captive over-wintering are quite variable with mortality of 20%-100% common, making it difficult to depend on retrieving live beetles. The Wisconsin DNR may make winter beetles available in the future if research shows that indoor-reared beetles establish well outdoors or if many teachers/cooperators want to try rearing entirely within the school year.

Start the previous spring by setting up several extra potted and netted plants. In summer, transfer up to 200 of your newly produced adults to each of these plants instead of releasing all the beetles into field sites. Three such plants with 200 beetles each should give you at least 100 beetles for the next year's propagation and hopefully many more. Captive beetles have to feed until September, so the plants must be big and healthy enough to withstand their feeding until then.

OUTDOOR METHOD

Simply allow the *Galerucella* beetles to over-winter outdoors on their new plants, either in their pool, covered with an inverted pool, or dug into the ground. These procedures help protect the beetles from the extremes of winter cold. Wait until the plants have died back to the ground before removing net cages and storing plants for the winter to be sure the beetles have fed adequately.

If using the pool method, either leave the nets on the pots or remove them when plants are ready, then bend or clip the old stems, add leaves for insulation and cover with another inverted pool, bolted to the first.

For pots dug into the ground, clip off the old stems when the plants are ready and place hardware cloth on top of the pots to protect plant roots and beetles from rodents. Dig a hole for each pot, place it into the hole and fill in around it with leaves and soil. Insulate the pot and beetles by heaping leaves or other insulation (but no straw) over the top, especially if winter snow cover is variable.

In the spring as soon as thawing starts, uncover pools and place all pots back into them, replacing net cages if previously removed. Pot new plant roots as early as possible from either roots harvested in the fall or dug immediately when your nearby wetland thaws so they are ready when your beetles emerge. This is especially important for captive, over-wintered beetles because they will emerge earlier than those in the wild. Collect any emerging *Galerucella* beetles and transfer them carefully to the newly dug, potted and netted plants.

Appendix 7.

REFRIGERATOR METHOD

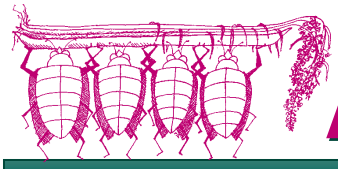
Beetles may also be over-wintered in the artificial cold of a refrigerator, as long as they are given a place to hide and not allowed to desiccate. One method is to make up several small bundles of 6" pieces of dry loosestrife stems tied together with string. Place each in a freezer bag with a piece of floral foam moistened with just as much distilled water as it will hold without dripping into the bag. Excess water can encourage condensation and harmful mold formation, but *Galerucella* beetles seem to tolerate some of this and desiccation is the more serious problem. Double bagging may reduce condensation and mold formation, as well as desiccation.

Transfer beetles when they have ceased feeding on their summer holding plants to the refrigerator bags, usually in mid-September. If collected too early, the beetles may not put on an adequate reserve of winter fat; if too late, the beetles will have moved into the soil to over-winter and be hard to find.

Place 50-100 *Galerucella* beetles in each bag and allow at least an hour for them to find hiding places in the stems. Try to simulate as gradual a temperature drop as possible before placing the bag(s) into a refrigerator, in order to avoid high mortality rates. Either take the temperature down gradually to close to freezing or place bags into the refrigerator for increasing periods of time. Remember that you are trying to imitate nature—the closer you can simulate the natural process, the more likely your beetles will survive.

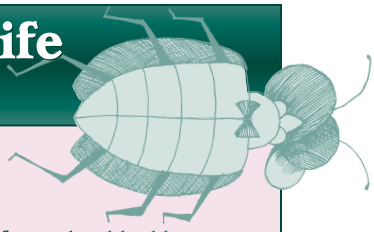
Collect new purple loosestrife roots for winter rearing in the fall, and store them moist, either outdoors under a shaded tarp, or in a root cellar at or below 40° F. Bring them into a warm, well-lit growing environment around the end of January, pot them, cover with net cages, and place in a pool or tub with water. They should grow to about two feet within 4-6 weeks and be ready for your *Galerucella* beetles. Gauge when that will be and shortly before it, retrieve pots with beetles from storage, replace their net cages if previously removed, and slowly bring them up to indoor temperatures. Collect any emerging beetles and transfer them gently to the new, netted plants for rearing.

If retrieving beetles from the refrigerator, gradually raise their temperature as in nature. Use an aspirator or other very gentle method to place 10 on each new plant.



APPENDIX 8

Easy Monitoring of Purple Loosestrife Biological Control Sites



A small amount of time spent monitoring can be very satisfying–and will often tell you if you should add more beetles to a site. The procedures outlined here are a simplified version of a more detailed process available to you on request. Your monitoring and reporting can help make the entire Purple Loosestrife Biological Control Project more effective. **Thank you!**

Spring beetle monitoring: On sunny, spring days, as the purple loosestrife at a *Galerucella* beetle release site grows to 1-2 feet tall, you should look for any adult beetles that have emerged from over-wintering and returned to feed and mate on the site's purple loosestrife plants. Also look for evidence of beetle feeding, as well as eggs and larvae, to help gauge the site's beetle numbers. Use the "Purple Loosestrife Beetle Spring Census" form provided to record and report your data. Please fill the form out completely and send it in promptly.

Do all monitoring on sunny days. As the purple loosestrife grows to 1-2 feet tall, take a walk through each site and take general notes on beetle numbers, their spread through the site, plant damage, etc. The plants usually grow to 1 foot by early May in the South and late May in the North. Once you start seeing beetles, count them using a consistent area measurer, such as a 1-square meter frame (the best) made of PVC tubing or a hula hoop. For comparisons over time and among sites, try to use the same measurer, keeping the size and shape of the area sampled consistent. On each site, mark with posts or flags the locations of at least several sample spots with loosestrife in them, but use 8-12, randomly chosen spots, if possible. Try to use these same spots every spring and the same number of sample spots at every site.

Put the frame or hoop down carefully at each spot to minimize disturbing the insects. Record the number of adult *Galerucella* beetles you see inside it in 1 minute. Use the abundance categories shown in the chart on the form, not actual numbers. If two people count, decrease counting time to 30 seconds for a total 1-minute count. If you see *Galerucella* eggs or larvae, do another 1-minute count for each type seen. Put these data into the appropriate boxes on the form, using the letters of the appropriate abundance categories. Note every year, by comparing numbers with previous years, if your beetle population is increasing. If it is not, or if you are not sure, and the site's purple loosestrife is still plentiful or even increasing (see late summer monitoring), add more beetles if you can to ensure a healthy beetle population and make the weed's demise that much quicker.

Summer: There is no beetle census form for this time, but try to visit your sites regularly through the summer to most easily see *Galerucella* eggs, larvae, and teneral (new) adults, as well as maximum plant damage! Take notes.

Late summer plant monitoring: When loosestrife flowering at a site is at its peak (when about the middle $^{2}/_{3}$ of most spikes are in bloom) stop at the site on a sunny day and photograph it from the photo point(s) you established in its first year. If flowering on a site lessens, you may need to watch flowering in nearby, uncontrolled sites to properly time your photos. Please send copies of photos with your "Purple Loosestrife Beetle Census" forms. Compare the amount of purple loosestrife flowering in newer photos with the comparable older photo(s) to document vegetation changes at the site. More purple than before generally means loosestrife has increased and suggests adding more beetles the next spring. Less purple usually signifies that so many larvae are present on the site, feeding on and killing stem tips where the flowers have to grow, that the current beetle population is doing well. If you see a lot less purple, smile, because fewer flowers mean fewer seeds—a major victory, even if purple loosestrife is never completely driven from the site!

Equipment needed for monitoring:

1. PVC posts or brightly colored flags
2. Area measurer, such as hula hoops or square meter frames
3. Clipboard, reporting form, pencil, watch
4. Original map of the site and any previous year census forms
5. Camera and previous site photos

Reporting: Mail copies of spring data forms and photos to Wisconsin Purple Loosestrife Biological Control Project, Wisconsin DNR Research Center, 1350 Femrite Dr., Monona, WI 53716.
E-mail at **brock.woods@dnr.state.wi.us** or call 608-221-6349 if you have questions, suggestions, or problems.

State of Wisconsin
Department of Natural Resources

Purple Loosestrife Beetle Spring Census

Form 3200-118 (5/03)

Notice: Use this voluntary form to monitor and report on your beetle populations. Information reported to the Department will be used for research and management purposes identified in s. 23.235, Wis. Stats. Personally identifiable information is not intended to be used for other purposes. Wisconsin's Open Records law requires the Department to provide this information upon request [ss. 19.31 - 19.69, Wis. Stats.].

Instructions: Each spring when purple loosestrife is 1-2 feet tall at a beetle release site, monitor the site on a sunny day for newly emerged *Galerucella* adults, eggs and larvae to see how the population is doing.

First, take notes on a walk through the site. Then put an area measurer, for example a 2.5 ft. diameter hoop or 1-meter square frame, down to mark a quadrat or sample area at each sample spot. Record the number of adult *Galerucella* beetles you see on purple loosestrife within it in one minute. Do not use actual beetle numbers--use the abundance categories from the chart below. Count beetles at several random spots--up to a dozen. Permanently mark the spots with posts to be used in future years. If two people count, decrease counting time by half to give a total 1 minute-person count. If eggs or larvae are present, do another 1 minute count for each type.

Reporting: Provide complete information. Mail copies of spring data forms and photos to:

Wisconsin Purple Loosestrife Biological Control Project
Wisconsin DNR Research Center, 1350 Femrite Dr., Monona, WI 53716
For additional information:
Telephone: 608-221-6349
E-mail: brock.woods@dnr.state.wi.us

Release Site and Observation Data

Site Name and/or Location

Observation Date	Time	Weather	Temperature
	☐ am ☐ pm		

Site Monitoring Data

Area Measurer Used

☐ 2.5-foot hoop ☐ 1-meter square frame ☐ Other (specify): _____

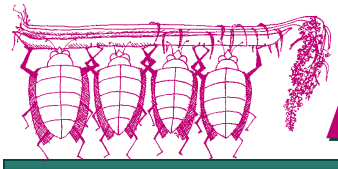
Year

Quadrat Number	Galerucella (use chart at right)		
	Eggs	Larvae	Adults
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			

Abundance Categories	
0	A
1-9	B
10-49	C
50-99	D
100-499	E
500+	F

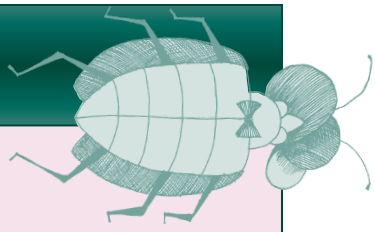
Field Notes

Observer Name(s)



APPENDIX 9

Purple Loosestrife Web Resources and References



INTERNET WEB SITES

[Internet URLs current at time of publication]

Purple Loosestrife

Wisconsin DNR web site: **www.dnr.state.wi.us**

See the following specific pages for information on loosestrife and its control:

- Bureau of Endangered Resources
- Aquatic Invasive Species
- EEK! Environmental Education for Kids

Wisconsin Wetlands Association web site: **www.wiscwetlands.org**

Includes information on purple loosestrife surveying, workshops, etc. Has a very good list of wetland resources for teachers and others.

Michigan State University web site: **www.miseagrant.org/pp**

Wonderful sets of activities, lessons for grades 4-5 and 6-12.

Illinois Natural History Survey web site:
www.inhs.uiuc.edu/chf/outreach/VMG/ploosestrife.html

Cornell University web site:
www.nysaes.cornell.edu/ent/biocontrol/weedfeeders/galerucella.html

Canadian Ducks Unlimited web site: **www.ducks.ca/purple/infosite/index.html**

Includes an on-line version of the pamphlet: "What You Should Know, What You Can Do" (**Note:** chemical control in Wisconsin *is* allowed over open water, but it requires a different herbicide (*Rodeo*) and a permit from the Wisconsin DNR.

Ontario Federation of Anglers and Hunters web site:
www.invadingspecies.com/index.cfm?DocID=24&Plant=Loosestrife

Vermont Department of Environmental Conservation web site:
www.anr.state.vt.us/dec/waterq/ans/plpage.htm

National Wildlife Refuge System web site: **http://refuges.fws.gov/habitats/index.html**

Biological Control, etc.

University of Guelph web site: **http://www.uoguelph.ca/mediarel/96-07-19/purple.html**

Includes examples of other efforts to battle this weed.

University of Wyoming web site: **http://w3.uwyo.edu/plants/weeds/id/**

Includes information on a purple loosestrife survey and ways to monitor this plant's spread.

Appendix 9.

The Nature Conservancy web site:
http://nature.org/wherewework/northamerica/states/wisconsin/science/art7.html
Includes an article from late in 2001 about battling purple loosestrife in Wisconsin.
Also see **http://nature.org/initiatives/invasivespecies/features/art8863.html**

Saskatchewan Purple Loosestrife Eradication Project web site:
http://broadway.sfn.saskatoon.sk.ca/science/splep/index.html
Describes another eradication program.

WRITTEN REFERENCES

Purple Loosestrife and Biological Control

Batra, S.W.T., et al. 1986. Insects associated with purple loosestrife (*Lythrum salicaria* L.) in Europe. *Proceedings of the Entomological Society of Washington* 88(4):748-759.

Blossey, B. and T.R. Hunt. 1999. Mass rearing for *Galerucella calmariensis* and *G. pusilla* (Coleoptera: Chrysimelidae), biological control agents *of Lythrum salicaria* (Lythraceae). *Journal of Economic Entomology* 92:325-334.

Blossey, B. 1995. A comparison of various approaches for evaluating potential biological control agents using insects on *Lythrum salicaria. Biological Control* 5:113-122.

Brown, D., A. Brown and S. Strathe. 1994. *Project W.U.L.P.: Wetland Understanding Leading to Protection*. Outdoor Skills Center, Inc.

Chapman, D., et al. 1999. *The Purple Loosestrife Cooperator's Handbook*. Michigan State University.

Jeffords, M.R. and S.L. Post. 1999. *Biodiversity, Wetlands and Biological Control: Information and Activities for Young Scientists; Purple Loosestrife: A Case Study*. Illinois Natural History Survey.

Loos, A. and D. Ragsdale. 2001. Biological control of purple loosestrife: A guide to rearing *Galerucella* spp. Unpubl. Rept. University of Minnesota. (Available from brock.woods@dnr.state.wi.us).

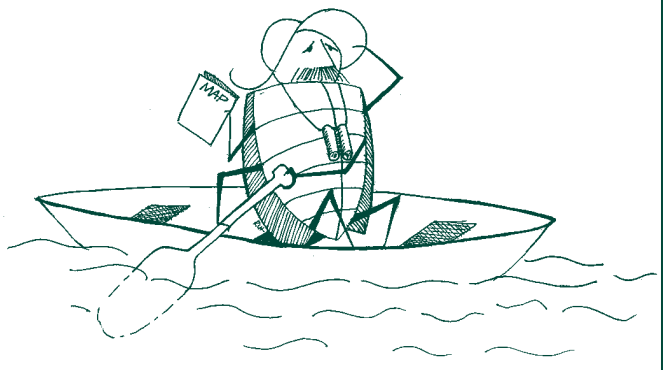
Plant Identification

Newcomb, L. 1977. *Newcomb's Wildflower Guide*. Little, Brown and Co.

Eggers, S. and D. Reed. 1997. *Wetland Plants and Plant Communities of Minnesota and Wisconsin.* U.S. Army Corps of Engineers. St. Paul, Minnesota.

Insect Identification

Milne, L. and M. Milne. 1992. *The Audubon Society Field Guide to North American Insects and Spiders*. Alfred Knopf, New York.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